Volume 23, Number 21 November 15, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 43474, 43475, and 43492.

Chemical Procedures

Refer also to abstract 43273.

43254 (BNWL-tr-41) EXTRACTION BY SOLUTION-LIGHT ABSORPTION QUANTIFICATION OF THORIUM(IV) USING XYLENOL ORANGE. Otomo, Makoto; Wakamatsu, Yoshinobu. Translated for Battelle-Northwest, Richland, Wash., from Nippon Kagaku Zasshi, 89: 1087-9(1968). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 9334. (auth)

43255 URANIUM AND THORIUM CONTENTS OF COEXISTING GNEISSES, GRANITES, AND PEGMATITES. Narayanaswamy, R.; Venkatasubramanian, V. S. (Indian Inst. of Science, Bangalore). Geochim. Cosmochim. Acta, 33: 1007-9(Aug. 1969).

U, Th, and K contents of gneisses, granites, and pegmatites of the Precambrian shield complex of SE Mysore were determined by gamma spectrometry. Th/U ratios in most gneisses and granites were found to have values in the range 5 to 15, being higher than the accepted value of about 3.5 for crustal material. (auth) (UK)

43256 FLAME EMISSION DETECTION AND DETERMINATION LIMITS FOR THE RARE EARTH ELEMENTS IN THE NITROUS OXIDE–ACETYLENE FLAME. Kniseley, Richard N.; Butler, Constance C.; Fassel, Velmer A. (Ames Lab., Iowa). Anal. Chem., 41: 1494-6(Sept. 1969).

Flame emission detection limits for all of the rare earth elements in the nitrous oxide–acetylene flame are reported, and the applicability of the flame as an emission source for the analysis of rare earth mixtures is appraised. A comparison of atomic emission and atomic absorption detection limits showed that in both water and alcohol solutions the detection limits in flame emission were significantly superior for 13 elements, essentially equal for Gd and Y, and Ce has not been detected in absorption. A Y_2O_3 sample containing Tb, Gd, Dy, Eu, La, and Yb as impurities at concentration levels equal to twice the calculated minimum determinable concentration values was examined. All of the elements, with the exception of Eu, could easily be determined with a relative standard deviation of ≈3%. (D.H.M.)

43257 DETERMINATION OF COBALT AND ZINC IN HIGH-PURITY NIOBIUM, TANTALUM, MOLYBDENUM, AND TUNGSTEN METALS BY ATOMIC-ABSORPTION SPECTROPHOTOMETRY AFTER SEPARATION BY EXTRACTION. Donaldson, Elsie M.; Charette, D. J.; Rolko, Vera H. E. (Dept. of Energy, Mines, and Resources, Ottawa). Talanta, 16: 1305-10(Sept. 1969).

A method for determining 0.0005 to 0.05% of cobalt and zinc in high-purity niobium, tantalum, molybdenum, and tungsten metals is described. After sample dissolution, cobalt and zinc are separated simultaneously from the matrix materials by chloroform extraction of their thiocyanate–diantipyrylmethane ion-association complexes, at pH 3.25, from a citric acid medium approximately 1.2M in sodium thiocyanate. Interference from copper is eliminated with thiourea. Large amounts of iron interfere under the recommended conditions, but moderate amounts may be present in the sample solution without causing appreciable error in the results. Phosphorus (as orthophosphate) interferes in the extraction of cobalt from tungsten solutions. Moderate amounts of other impurities do not interfere in the proposed method. (auth) (UK)

43258 SPEKTRAL'NYI ANALIZ V GEOLOGII I GEOKHIMII. MATERIALY VTOROGO SIBIRSKOGO SOVESHCHANIYA PO SPEKTROSKOPII. (Spectral Analysis in Geology and Geochemistry. Material of the Second Siberian Conference on Spectroscopy). Raikhbaum, Ya. D.; Chernenko, A. I.; Malykh, V. D.; Molodykh, K. A.; Serd, M. A. (eds.). Moscow, Izdatel'stvo Nauka, 1967. 248p.

Seventy-five reports are included on spectral analysis of powdered specimens and uses of spectral analysis for resolving various problems in geochemistry, geology, and technology of mineral resources. The reports are divided into 5 sections. The first section deals with chemical reactions in arc plasma and arc electrodes, chemical processes in the spectral excitation sources, and chemical reactions on the surface of electrode channels. The physical processes in light sources, mechanisms of electrode transitions into plasma, and vapor passage through the spectrum excitation zone are discussed in the second section. The sensitivity and precision of emission spectral analysis and means for increasing its sensitivity are covered in the third section. The fourth section handles the methods of treating analytical data, including optimization, automation, and mechanization of analytical operations. Technological processes in treating mineral resources, qualitative and quantitative determinations of various minerals (W, Be, Pb, Sn, Cu, Li, Zr, Nb, Sc, Y, Yb, etc.) in rocks, spectrographic determination of rare earths and Y in rare earths without chemical separation, and atomic-absorption analysis of mercury are discussed in the last section. (R.V.J.)

43259 QUANTITATIVE ANALYSIS OF LIGHT ELEMENTS WITH PRIMARY STIMULATED X-RAYS. Vollath, D. Mikrochim. Acta, Suppl. III, 1-10(1968). (In German).

The effects of the state of combination on the height and position of some B and O peaks in x-ray fluorescence spectra were studied; the effects of exciting voltage on peak heights are discussed in the cases of O in Al_2O_3 and UO_2 and of C in graphite. (Metals Abstr.)

43260 THE SIMULTANEOUS SPECTROPHOTOMETRIC DETERMINATION OF OSMIUM AND RUTHENIUM. Berg, Eugene W.; Moseley, H. E. (Louisiana State Univ., Baton Rouge). Anal. Lett., 2: 259-67(May 1969).

A spectrophotometric procedure is described for the simultaneous determination of Os and Ru in the form of bromo complexes. A blue Ru thiourea complex can be formed in 6.7M HBr solutions while the Os can be maintained as the hexabromoosmate complex. Absorption maxima are at 620 mμ for the Ru complex and at 446 mμ for the Os complex; for the Ru complex is 2.47×10^3 at 620 mμ and 763 at 446 mμ. For the Os complex molar absorptivity is 328 at 620 mμ and 6.81×10^3 at 446 mμ. The method is useable over the range of 5 to 30 ppM; the absolute error of ±1 ppM over the range. Other Pt metals interfere. A recommended procedure follows for the determination of Ru in the presence of Os. To an aliquot of a mixture of Os and Ru bromides containing between 5 and 30 ppM of the elements, add 10 ml 48% HBr, then 2 ml 10% (wt/wt) thiourea; dilute to 25 ml with 6M HBr. After a 15-min development time, measure the absorbance at 620 mμ and 446 mμ in a 1-cm cell against a blank of 6M HBr. (BBB)

43261 DETERMINATION OF CERIUM IN MINERALS WITH SULPHANILIC ACID. Pollock, E. N. (Kennecott Copper Corp., Lexington, Mass.). Talanta, 16: 1323-6(Sept. 1969).

Cerium can be determined colorimetrically in minerals with sulphanilic acid. Cerium(III) ions are oxidized with silver(II) in 1 to 7% sulphuric acid and sulphanilic acid is oxidized by cerium(IV) ions in 20% sulphuric acid. The absorbance is determined at 540 nm. In the presence of manganese or chromium, cerium can be separated by precipitation as the oxalate. Lanthanum can be used as a gathering agent, if necessary. (auth) (UK)

43262 ANALYSE STABILER ISOTOPE DURCH SPEZIELLE METHODEN. (Analysis of Stable Isotopes by Special Methods). Mueller, Guenter; Mauersberger, Kurt; Spring, Helmut. Berlin, Akademie-Verlag GmbH, 1969. 310p. 45.-M.

A comparison was made of the various methods for analysis of stable isotopes. Topics covered include: error considerations, katharometry, densimetry, refractometry, electrometry, effusiometry and viscosimetry, tensiometry and cryometry, spectroscopy, nuclear magnetic resonance, gas chromatography, and radiometry. (M.C.G.)

Isotopic Procedures

Refer also to abstract 43520.

43263 (NP-tr-1832) STUDIES ON SULFUR-CONTAINING CHELATING AGENTS. 19. RADIOISOTOPE DILUTION METHOD FOR DETERMINATION OF INORGANIC AND ORGANIC MERCURY BY PAPER CHROMATOGRAPHY. Tanaka, H.; Sugiura, Y.; Yokoyama, A. Translated by B. K. Bowes (Atomic Energy Research Establishment, Harwell, Eng.), from Bunseki Kagaku, 17: 1424-7(1968). 8p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 6085.

43264 SUBSTOICHIOMETRIC RADIOISOTOPE DILUTION ANALYSIS OF TUNGSTEN AS A MAJOR CONSTITUENT IN MOLYBDENUM CONTAINING MATERIALS USING TOLUENE-3, 4-DITHIOL. McClendon, L. T.; DeVoe, J. R. (National Bureau of Standards, Washington, D. C.). Anal. Chem., 41: 1454-6 (Sept. 1969).

A substoichiometric radioisotope dilution method for determining tungsten in materials containing molybdenum is presented in which tungsten is complexed with toluene-3,4-dithiol and extracted into chloroform. In the analysis of NBS W–Mo alloy, molybdenum is separated prior to the tungsten analysis and since the tungsten complex is extracted from acidic and strongly reducing medium there is no molybdenum interference from the small amount left in solution from the separation step. (D.H.M.)

Radiometric Procedures

Refer also to abstract 45143.

43265 SUBSTOICHIOMETRIC DETERMINATION OF CADMIUM IN BIOLOGICAL SAMPLES. Bibr, B.; Lener, J.; Zeman, A. (Faculty Technical and Nuclear Physics, Prague). J. Radioanal. Chem., 3: 81-6(July 1969).

A method is suggested for the determination of submicrogram Cd in quantities by isotope dilution using substoichiometric extraction into dithizone in chloroform. The applicability of the method was tested in biological samples. Extraction was carried out from a sodium acetate buffer between pH 9.7 and 12.0. This method is suitable for large scale analysis of trace amounts of Cd in biological materials. (auth)

43266 GAS-COULOMETRIC DEVICE FOR REMOTELY DOSING RADIOACTIVE LIQUIDS. Braun, T.; Merenyi, G. (Eoetvoes Univ., Budapest). J. Radioanal. Chem., 3: 93-7(July 1969).

A modified coulometric feeder was designed for remote analysis of radioactive liquids. The gas produced by electrolysis in a closed vessel is held at a constant pressure checked by a gauge. As a result the displaced liquid volume is strictly proportional to the volume of the gas. (auth)

43267 APPLICATION OF GAMMA-SPECTROMETRY IN DETERMINING CHLORINE IN AQUEOUS SOLUTIONS. Yazikov, I. F.; Rodin, N. N.; Dembrovskii, M. A.; Lambrev, V. G. (Research Inst. of the Chlorine Industry, Moscow. Karpov Physico-Chemical Research Inst., Moscow). J. Radioanal. Chem., 3: 11-16(July 1969).

A method is described for the radioanalytical determination of traces of chlorine in aqueous solutions without radiochemical separation or purification. A gamma spectrometer with monocrystal scintillator was used. The sensitivity of the analysis was about 1×10^{-9} g of chlorine/ml, the time of analysis, 15 minutes. For the selective determination of chlorine in aqueous solutions containing a large amount of impurities, a bicrystal scintillation sum-coincidence spectrometer was employed with 120 × 100 mm NaI(Tl) crystals and thus the ^{38}Cl cascade radiation could be used. Application of the sum-coincidence spectrometer allowed a reliable determination of 1×10^{-7} g of Cl/ml against a background of 1×10^{-4} g of Na/ml. (auth)

43268 DETERMINATION OF HIGH CADMIUM CONTENTS IN INDUSTRIAL MATERIALS BY BACK SCATTERING OF β PARTICLES. Kwiecinski, Stanislaw; Lubecki, Anatol. Rudy Metale Niezelaz., 14: 335-6(June 1969). (In Polish).

Backscattering of β particles was used for the determination of high cadmium contents in industrial materials. The radioisotope $^{90}Sr + ^{90}Y$ was used as a source of β particles and a scintillation counter was used as the detector. The absolute error of the determination was 0.5 per cent cadmium for 80 to 90 per cent cadmium concentrations. (auth)

43269 ISOLATED INTERNAL STANDARD FOR DETERMINING THE EFFICIENCY OF THE CONTINUOUS MEASURING METHOD OF SAMPLES LABELED WITH ^{14}C. Szarvas, T.; Vegh, G.; Oemboely, Cs. (MTA Izotop Intezete, Budapest). Atomtech. Tajek., 11: 344-8(July 1968). (In Hungarian).

An isolated internal standard proved to be advantageous for routine analyses, and the most precise for correcting the quench effect of liquid scintillators. The standard can be applied to the activity measurement of colored samples. The activity of the standard remains unchanged even in acidic media. (auth)

43270 PULSED NEUTRON METHOD FOR NON-DESTRUCTIVE AND SIMULTANEOUS DETERMINATION OF THE ^{235}U AND ^{239}Pu CONTENTS OF IRRADIATED AND NON-IRRADIATED REACTOR FUEL ELEMENTS. Krinninger, H.; Wiesner, S.; Faber, C. (Internationale Atomreaktorbau GmbH, Bensberg, Ger.). Nucl. Instrum. Methods, 73: 13-33(1969).

The procedure investigated for the non-destructive determination of the fuel content of irradiated or non-irradiated reactor fuel elements based on detecting the prompt neutrons released by induced nuclear fissions. To differentiate between the two fissile isotopes ^{235}U and ^{239}Pu and for quantitative analysis, their different energy-dependent fission cross sections are used. For this purpose the fuel element to be investigated is successfully exposed to two externally generated neutron fluxes with different mean neutron energies, i.e., 0.3 eV and 0.025 eV. The prompt fission neutrons are detected by a proton-recoil scintillation counter. A lead spectrometer serves for producing the different neutron fluxes. With the method described, called the slowing-down-time method, the fuel concentrations N_5 (number of ^{235}U-atoms/cm^3) and N_9 (number of ^{239}Pu atoms/cm^3) in each individual fuel rod could be determined with an accuracy of ≤5% by one measurement lasting 30 minutes in each case for the used experimental set up. (auth)

43271 INDIRECT DETERMINATIONS BY β^- BACKSCATTERING METHOD. III. DETERMINATION OF LITHIUM. Marcu, Gh., Sacelean, V. Stud. Univ. Babes-Bolyai, Ser. Chem., 14: 139-41 (1969). (In Rumanian).

The precipitation reaction of lithium as $LiZn[UO_2(CH_3COO)_3]_3 6H_2O$ was used in an indirect determination of lithium by backscattering of β^- radiation. This method permits the determination of lithium between 1.4 to 7.2 mg with a median error of 2.15% and can be used for series analyses. (auth)

43272 ASSAY OF DIAGNOSTIC RADIOISOTOPES IN LARGE LIQUID VOLUMES WITH A WELL-TYPE CRYSTAL IN THE END-ON POSITION. Bell, T. K. (Royal Victoria Hospital, Belfast). J. Clin. Pathol., 22: 240-1(1969).

The performance obtained from a NaI well-type counter, used in the end-on position for direct counting of ^{129}I, ^{57}Co, ^{51}Cr, ^{131}I, ^{58}Co, and ^{59}Fe in large liquid volumes was compared with that obtained from a counter that had 6 G–M tubes. There was little variation in counting rate in the G–M counter over the range 100 to 600 ml while the counting rate in the end-on position of the well-type crystal fell by about a factor of 2, with the exception of ^{125}I. The factor was greater for this isotope because of considerable self-absorption and inverse-square law effects. No counts were obtained from ^{125}I in the G–M counter. With use of the well crystal, the background counts fell as γ-ray energy increased. A comparable or higher count/background figure was obtained for volumes up to 600 ml using the well-type NaI crystal in the end-on position under these geometrical conditions than with the G–M counter. (BBB)

Activation Procedures

Refer also to abstracts 43583 and 44503.

43273 (CONF-690815-5) CURRENT AND POTENTIAL APPLICATIONS OF RADIOISOTOPE X-RAY AND NEUTRON TECHNIQUES OF ANALYSIS IN THE MINERAL INDUSTRY. Mineral Beneficiation Paper No. 4. Watt, J. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 20, 1969. 20p. Dep. CFSTI (U. S. Sales Only).

From Conference of the Australian Institute of Mining and Metallurgy, Sydney, Australia.

Radioisotope x-ray and neutron techniques of analysis can be used for the determination of a wide range of elements in minerals. The most important applications of these techniques to the mineral industry are for on-stream analysis of slurries and solids, and for geological assay. The radioisotope x-ray techniques are the more developed ones and two installations for on-stream analysis are in routine use in mineral processing plants in Australia. Neutron techniques are being developed, and should prove valuable for geological assay of large numbers of mineral samples, for borehole logging, and for specific on-stream analysis when the cost of the equipment is warranted. (D.H.M.)

43274 (Y-1686) DETERMINATION OF OXYGEN BY NEUTRON ACTIVATION ANALYSIS. Tucker, W. O. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 4, 1969. Contract W-7405-eng-26. 17p. Dep. CFSTI.

Activation analysis, using 14-MeV neutrons, was used to determine oxygen in a variety of materials at concentrations from less than 100 ppM to 30 percent. The system uses a sealed-tube neutron generator with a pneumatic transfer system and dual-axis rotation during the irradiation period. The relative percent error for a single determination (95% confidence level) varies from ±18% at the 70-ppM level at ±3.4% at the 1% level and ±2.6% at the 30% level. (auth)

43275 DETERMINATION OF BERYLLIUM IN ROCKS BY NEUTRON ACTIVATION ANALYSIS. Sachanbinski, Michal; Szuszkiewicz, Marian. Rudy Metale Niezelaz., 14: 331-5(June 1969). (In Polish).

A detailed description is given of the application of neutron activation analysis to the determination of beryllium in ores and rocks, and a laboratory device constructed for this purpose is described. (P.C.H.)

43276 ACTIVATION ANALYSIS SECTION AT THE NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C., U. S. A. J. Radioanal. Chem., 3: 127-33(July 1969).

The activities and facilities of the Activation Analysis Section of the National Bureau of Standards are reviewed. The Section is responsible for development of new techniques, refinement of existing techniques, increasing the applicability of activation analysis, and the reduction of cost of analyses. The Section participates in the certification of the Standard Reference Materials issued by the National Bureau of Standards, and in the service analysis problems of the Analytical Chemistry Division. (J.G.B.)

43277 DETERMINATION OF ALUMINUM AND CHLORINE IN COMPOSITE PROPELLANTS BY NONDESTRUCTIVE ACTIVATION ANALYSIS USING A MIXTURE OF 14.5 MeV AND SLOW NEUTRONS. Richardson, A. E.; Harrison, Alex (Dept. of the Army, White Sands Missile Range, N. Mex.). Anal. Chem., 41: 1396-9 (Sept. 1969).

Use of a mixture of 14.5-MeV and slow neutrons makes possible the simultaneous determination of aluminum and chlorine in solid composite propellants by nondestructive activation analysis with a precision of better than ±1%. The method was developed and evaluated by carrying out a series of determinations on samples of known composition and comparing the results with those obtained by x-ray fluorescence. The overall agreement between the results of the two methods is quite good, and both appear to be sufficiently accurate for quality control purposes. (auth)

43278 FLUORINE ANALYSIS BY ACTIVATION WITH AN ISOTOPIC FAST-NEUTRON SOURCE AND COUNTING ^{16}N. Wing, J.; Wahlgren, M. A. (Argonne National Lab., Ill.). J. Radioanal. Chem., 3: 37-42(July 1969).

A rapid, nondestructive method was developed for the determination of fluorine by activation with fast neutrons from a ^{241}Am–^{242}Cm–Be source and counting of the 6 to 7 MeV γ rays of the product nitrogen-16. The total neutron output of the source is 4.8×10^9 unmoderated neutrons per second and the flux is 1.4×10^8 fast $n \cdot cm^{-2} \cdot sec^{-1}$. The γ-ray detectors consist of two opposing, matched cylindrical NaI(Tl) crystals 10 cm long and 10 cm in diameter. The sample is irradiated for 30 seconds, cooled for 4 seconds, and then counted for 30 seconds. The sensitivity is 4.8×10^4 counts nitrogen-16 per gram fluorine, and the limit of detection is 0.4 mg fluorine in a 10 gram sample. A reproducibility of 0.24% was achieved. The relative standard deviation of the specific count rate of nitrogen-16 for 11 fluorine compounds was 1.31%. (auth)

43279 ACTIVATION ANALYSIS DETERMINATION OF CHROMIUM AND ZINC IN BIOLOGICAL MATERIALS. Behne, D. (Hahn-Meitner Institut, Berlin). J. Radioanal. Chem., 3: 17-24 (July 1969). (In German).

An activation analysis method was developed for the determination of chromium and zinc in biological material. After the samples had been activated in a thermal flux of 7×10^{11} $n \cdot cm^{-2} \cdot sec^{-1}$ for 100 hours, both elements were separated from interfering radionuclides by means of ion exchange and distillation processes. Gamma spectrometry was used to measure the activities of ^{51}Cr and ^{65}Zn. The practical limits of detection were found to be 1×10^{-8} for chromium and 1×10^{-7} g for zinc. The results of model experiments and of the analysis of blood taken from two individuals proved to be accurate and reproducible. (auth)

43280 NUCLEAR PHOTOACTIVATION ANALYSES BY MEANS OF AN 80-kCi ^{60}Co γ-RADIATION SOURCE. Veres, A.; Pavlicsek, I. (Inst. of Isotopes, Budapest). Radioanal. Chem., 3: 25-8(July 1969).

An analytical method was developed for the determination of Se, Br, Sr, Ag, Cd, and In in some mixtures applying (γ,γ')-type reactions. The method provides a high degree of selectivity and precision if the concentration of the element in the sample is a few per cent or more. Using an 80 kCi ^{60}Co gamma-radiation source, as low as 0.002 to 0.14% impurities could be determined in 50 g samples; this corresponds to 1 to 70 mg quantities of the particular elements. (auth)

43281 DISTRIBUTION OF ARSENIC RESIDUES BY ACTIVATION ANALYSIS. Geisman, J. R.; Carey, W. E.; Gould, W. A.; Alban, E. K. (Ohio Agricultural Research and Development Center, Wooster, Ohio). J. Food Sci., 34: 295-8(May-June 1969).

A method using neutron activation analysis was developed for As that required only drying of samples and encapsulation. Using activation analysis, it was found that arsenic was concentrated in the root of tomato plants. Data indicated a discrimination within the plant between fruit, stems and leaves, and root. Thus, it was concluded that soil concentrations of arsenic would have to be at the level that causes a reduction in fruit size and/or yield before fruit concentration of arsenic would exceed the tolerance. This situation is not likely to occur at concentrations used for defoliation of horticultural crops prior to mechanical harvest. Activation analysis could be used to detect microgram quantities of arsenic in milligram size samples. The method was precise and repeatable and did not require elaborate sample preparation techniques. (auth)

43282 STUDY OF RUTHENIUM PARTITION IN AN ECOLOGICAL POND USING NEUTRON ACTIVATION ANALYSIS. Neuburger, M.; Fourcy, A. (CEN, Grenoble, France). Int. J. Appl. Radiat. Isotop., 20: 641-51(Sept. 1969). (In French).

Ruthenium is one of the components of radioactive wastes issuing from nuclear experimentation. As ruthenium radioisotopes show the same biological behavior as stable ruthenium, it was suggested to study the partition of a low intake of nonradioactive Ru in an ecological pond which was initially nearly free of natural Ru. For this purpose, water, sediments, aquatic and semiaquatic plants are periodically taken off and analyzed using neutron activation analysis. (auth) (UK)

43283 DETERMINATION OF URANIUM IN ROCKS BY INSTRUMENTAL ACTIVATION-ANALYSIS USING EPITHERMAL NEUTRONS. Steinnes, E. (Institut for Atomenergi, Kjeller, Norway); Brune, D. Talanta, 16: 1326-9(Sept. 1969).

A rapid nondestructive neutron activation method for the determination of uranium in rocks is described. The method is based on activation with epithermal neutrons and subsequent measurement of the 74-keV γ-ray of ^{239}U. Results given for some standard rocks are in good agreement with literature data. The precision of the method is about 5% and the limit of detection is of the order of 0.1 ppM in silicate rocks. (auth) (UK)

43284 PHOTOACTIVATION ANALYSIS OF ANTIMONY–ZIRCONIUM ION EXCHANGERS. Kotel'nikov, L. A.; Kuznetsov, R. A. Radiokhimiya, 11: 256-8(1969). (In Russian).

The irradiation was carried out in the internal betatron beam with a bremsstrahlung energy of 25 MeV. Finely powdered sam-

ples in standard aluminum cells were irradiated for one minute and coincidence techniques were used to measure the activity of the sample. Amounts of oxygen, antimony, and zirconium were determined. (M.C.G.)

43285 NEUTRON ACTIVATION ANALYSIS IN MEDICINE. Altmann, H. (Institut fuer Biologie und Landwirtschaft, Seibersdorf, Austria). Wein Tieraerztl. Monatsschr., 54: 756-63(Nov. 1967). (In German).

Some examples of the use of neutron activation analysis in veterinary, human, and forensic medicine are given. (M.C.G.)

43286 THEORY OF PARTIAL IDENTIFICATION IN ACTIVATION ANALYSIS. Zinovev, N. V. At. Energ. (USSR), 27: 128-30(Aug. 1969). (In Russian).

A mathematical method is given for partial identification during activation analysis of complex compounds. (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 44018, 44022, 44562, 44576, and 44776.

43287 (COO-1109-46) THE SOLID STATE CHEMISTRY OF RARE EARTH OXIDES. Technical Progress Report, 1968-1969. Eyring, LeRoy; Herrick, Claude C.; Jenkins, Michael S.; Fox, Donald L.; Turcotte, Rheal P.; Weber, Gary R. (Arizona State Univ., Tempe). July 10, 1969. Contract AT(11-1)-1109. 122p. Dep. CFSTI.

Developments are reported for studies on: an accurate automatic read-out for thermobalances; pseudo-phase behavior in the praseodymium oxide system; the praseodymium oxide system; rare earth formates; yttrium sesquioxide; heterogeneous oxygen exchange behavior of a sample of $PrO_{1.783}$ spheres; equilibrium dissociation studies at low oxygen pressures; and single crystal growth using hydrothermal techniques. (P.C.H.)

43288 (COO-1440-17) AN INVESTIGATION OF MIXED CONDUCTION IN SOLID ELECTROLYTES. Progress Report. Rapp, Robert A. (Ohio State Univ. Research Foundation, Columbus). Aug. 14, 1969. Contract AT(11-1)-1440. 9p. Dep. CFSTI.

Developments are reported for studies on proton conduction in oxide electrolytes and mixed conduction and ionic equilibria in molten $NaCl-TiCl_x$ solutions. Also the apparatus for the measurement of free energy of formation of UO_2 has been completed. The results on proton conduction verified partial proton conductivity in ThO_2-based solutions and established the dependence of proton conductivity on temperature, vacancy concentration, and partial pressures of O and of H. The theoretical treatment and electrochemical cell for mixed conduction studies are described. (P.C.H.)

43289 (IS-T-292) INFRARED SPECTRA AND VIBRATIONAL ANALYSES OF SOME DIMERIC TRANSITION METAL PENTAHALIDES. Smardzewski, Richard Roman (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 128p. Dep. CFSTI.

Thesis.

The far infrared absorption spectra of a number of dimeric metal(V) halides have been determined. Absorption spectra in the metal-halogen fundamental region of the infrared were obtained for the solid dimeric transition metal pentahalides: Nb_2X_{10} (X = Cl, Br, I), Ta_2X_{10} (X = Cl, Br, I), W_2X_{10} (X = Cl, Br), Mo_2Cl_{10}, and Re_2Cl_{10}. The infrared spectra of all of the dimeric metal(V) halides studied were interpreted on the basis of a M_2X_{10} molecular model of D_{2h} symmetry which possesses two halogen atoms symmetrically bridging two heavy metal atoms. Twelve out of a possible thirteen predicted infrared active fundamentals have been observed for each of the dimeric transition metal pentahalides. Assignments of the vibrational frequencies were established for each of the dimeric metal(V) halides except Nb_2I_{10} where, because of complicated mode-coupling effects, a frequency assignment and subsequent vibrational analysis was not possible. The infrared spectra of saturated cyclohexane solutions of rhenium(V) chloride also indicated the presence of stable Re_2Cl_{10} units. The terminal M-X bond stretching force constant, f_T, and the bridged M-X bond stretching force constant, f_B, were examined as functions of both the transition metal atom and the associated halogen atom. A comparison of the terminal and bridged M-Cl bond stretching force constants of the compounds M_2Cl_{10} (M = Nb, Ta, Mo, W, Re) qualitatively demonstrated the greater strength of the metal-chlorine (bridge) bond in the case of the dimeric pentachlorides of the Group VIB and VIIB heavy metals as compared to the dimeric pentachlorides of the Group VB metals. It was also concluded that the M-Cl (bridge) bond strength relative to the M-Cl (terminal) bond strength is greater for the lighter metals of the Group VB and VIB dimeric pentachlorides. From the final calculated L' matrices of the M_2X_{10} compounds, it was established that the character of an individual metal-halogen vibration becomes increasingly complex as the halogen atom becomes massive in comparison to the transition metal atom. Large vibrational mode interaction effects were observed for the case of the heavier halides of a particular transition metal. (101 references) (P.C.H.)

43290 (KFK-tr-291) CHEMICAL EXPERIMENTS WITH ELEMENT 104-KURCHATOVIUM. II. CHEMICAL INVESTIGATION OF SPONTANEOUS FISSION OF ISOTOPES OF HALF LIFE 0.3 SECONDS. Zvara, I.; Chuburkov, Yu. T.; Tsaletka, R.; Shalaevskii, M. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR-P7-3783. 29p. (In German). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 22: 35772.

43291 (MLM-1603) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: JANUARY-MARCH 1969. (Mound Lab., Miamisburg, Ohio). Sept. 5, 1969. Contract AT-33-1-GEN-53. 40p. Dep. CFSTI.

Developments are reported for a NMR study of the structure of β-isopropyltropolone complex of uranium and for $ThCl_4 \cdot 2Bu_3PO$. Some consequences of including Pu(V) in the scheme of disproportionation of Pu(IV) ion in dilute aqueous acid are discussed. Progress in the field of separation chemistry is reported on residue adsorption (desorption of ^{231}Pa adsorbed on glass using isopropanol-HCl; ^{234}U recovery; ^{229}Th recovery; and ^{206}Pb recovery. The $^{20}Ne(d,n)^{21}Na$ reaction was studied from 3 to 6 MeV bombarding energy, and the neutron total cross sections were measured with 2-keV resolution for 0.82- to 1.8-MeV neutrons on ^{40}Ca and also for energies near 3 MeV on ^{16}O. A one step process for coating beryllium oxide with nickel was developed. (D.H.M.)

43292 (RLO-244-8) STUDY OF GENERALIZED ACID-BASE PHENOMENA IN NON-AQUEOUS IONIZING SOLVENTS WITH RADIOACTIVE TRACERS. Final Report. Norris, T. H. (Oregon State Univ., Corvallis. Dept. of Chemistry). July 28, 1969. Contract AT(45-1)-244. 38p. Dep. CFSTI.

An extensive investigation of acid-base and related phenomena in nonaqueous ionizing, or supposedly ionizing solvents was conducted. The experimental approach involved primarily techniques employing radioactive tracers. Solvents investigated included liquid sulfur dioxide, sulfur trioxide, thionyl chloride, sulfuryl chloride thionyl bromide, phosphorus oxychloride, selenium oxychloride, acetic acid, acetic anhydride, concentrated sulfuric acid, fused ammonium bisulfate, liquid hydrogen sulfide, and sulfur monochloride. Results indicate that the once well regarded solvent systems concept of acid-base behavior has probably been overemphasized in a number of cases. Rather a broader viewpoint based essentially on the Lewis approach to such phenomena appears more inviting. A brief review of the work done on the project is provided, together with a bibliography of publications. (auth)

43293 ISOTOPIC DISTRIBUTIONS IN EXOTHERMIC ION-MOLECULE REACTIONS. A SIMPLE MODEL. Light, J. C.; Chan, S. (Univ. of Chicago). J. Chem. Phys., 51: 1008-15 (Aug. 1, 1969).

A simple model of exothermic ion-molecule reaction is proposed in which the isotopic distribution of products is due to the separations of the center of charge from the center of mass of the diatomic reactant. Applications to the energy dependence of the isotope ratio of products of the reactions Ar + HD^+ and Kr + HD^+ indicate that this factor may be predominant in the energy range of 1 to 10 eV (center of mass). (auth)

43294 CHLOROURANATES(V). Stumpp, Eberhard (Univ., Tuebingen, Ger.). Naturwissenschaften, 56: 370(July 1969). (In German).

A method was developed for the preparation of chlorouranates(V) by reaction of UO_3 or U_3O_8 and the corresponding alkali metal chloride with $SOCl_2$. Properties of some of the compounds were studied. (M.C.G.)

43295 VAPOR PRESSURE ISOTOPE EFFECT IN NEOPENTANE. Hoepfner, A.; Parekh, N. (Univ., Heidelberg). Naturwissenschaften, 56: 369(July 1969). (In German).

The effects of deuterium on the vapor pressure of neopentane were measured and data are presented in a graph. (M.C.G.)

43296 STRUCTURE AND CONFORMATION OF TRIMETHYLAMINE. Wollrab, James E. (McDonnell Douglas Corp., St.

Louis); Laurie, Victor W. J. Chem. Phys., 51: 1580-3(Aug. 15, 1969).

The ground-state rotational spectra of $(CH_3D)(CH_3)_2N$, $(CH_3)_3{}^{15}N$, and $({}^{13}CH_3)(CH_3)_2N$ were assigned yielding the effective moments of inertia. This information was combined with that for $(CH_3)_3N$ to give the following structural parameters: r(CN) = 1.451 ± 0.003 Å; $r(CH_s)$ = 1.109 ± 0.008 Å; $r(CH_a)$ = 1.088 ± 0.008 Å; ∠CNC = 110.9° ± 0.6°; $\angle NCH_s$ = 111.7° ± 0.4°; $\angle NCH_a$ = 110.1° ± 0.5°; $\angle H_sCH_s$ = 108.1° ± 0.7°; and $\angle H_aCH_a$ = 108.6° ± 0.8°, where H_s lies in a symmetry plane A C_s, equilibrium conformation was established and the methyl groups appear to be tilted by 1.3° toward the unshared electron pair. (auth)

43297 LOW-TEMPERATURE OPTICAL ABSORPTION OF AMERICIUM HALIDES. Pappalardo, R. G.; Carnall, W. T.; Fields, P. R. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 1182-1200(Aug. 1, 1969).

Absorption spectra at low temperatures are reported for $AmCl_3$, $AmBr_3$, and AmI_3. Bathochromic shifts were generally observed in the series from the chloride to the iodide. These shifts are comparable to those observed in lanthanide halides. Hypersensitive transitions were observed in AmI_3. A number of new assignments of excited levels of Am(III) are proposed on the basis of intensity calculations. Electrostatic, spin–orbit, and configuration–interaction parameters were obtained by direct diagonalization and least-squares fitting to 29 observed levels for $AmCl_3$. The parameter values in cm^{-1} are: E^1 = 3582.8, E^2 = 17.276, E^3 = 334.30, ζ_{5f} = 2593.3, α = 21.634, β = −158.48, γ = 1240.4. (auth)

43298 INFRARED SPECTRA OF CARBON MONOXIDE IN ZEOLITES. Fenelon, P. J.; Rubalcava, H. E. (University Coll., Dublin). J. Chem. Phys., 51: 961-7(Aug. 1, 1969).

The infrared spectra of $^{12}C^{16}O$ and of a mixture of $^{12}C^{16}O$ and $^{13}C^{16}O$ in the zeolite NaA show bands that were assigned as R-, Q-, and P-branch maxima of a relatively free rotor. This conclusion depends, partly, on small but experimentally distinguishable differences in the isotope shift of the bands of a pure vibrator and those of a vibrotor. The spectrum of carbon monoxide in the zeolite NaX is similar to that in NaA. However, in CaA, and in CaX, where it is known that CO is more strongly adsorbed than in the sodium zeolites, the bands have a different structure, corresponding to a strongly hindered rotor. (auth)

43299 INFRARED SPECTRUM OF ANTHRACENE-d_{10}. Bree, A.; Kydd, R. A. (Univ. of British Columbia, Vancouver). J. Chem. Phys., 51: 989-95(Aug. 1, 1969).

The infrared spectrum of anthracene-d_{10} is reported with the electric vector of the plane-polarized incident light parallel to all three crystal axes; thus the c-polarized spectrum is recorded for the first time. The measurements extend from 2000 to ~50 cm^{-1}; the single-crystal samples used were too thick to transmit radiation in the strongly absorbing region near 2260 cm^{-1} so that little new data are available concerning the CD stretching fundamentals. However, a fairly complete assignment of the molecular fundamentals at lower energy is presented, based on the criteria of line strength and polarization, and the product rule. A comparison with calculated frequencies and some earlier experimental assignments is given. (auth)

43300 SPECTRA, STRUCTURES, AND BONDING OF SOME URANIUM(IV) CYCLOPENTADIENYLS. Anderson, Melvin L.; Crisler, Larry R. (Dow Chemical Co., Golden, Colo.). J. Organometal. Chem. (Amsterdam), 17: 345-8(1969).

Some data are reported on tetracyclopentadienyluranium, UCp_4, tricyclopentadienyluranium chloride, UCp_3Cl, and tricyclopentadienyluranium tetrahydroborate, UCp_3BH_4 (Cp = C_5H_5). Some mention is also made of the tricyclopentadienyluranium ion, UCp_3^+. The preparation and properties of UCp_3BH_4, reported are described and discussed. (auth)

43301 COMPOUNDS OF RARE EARTH METALS WITH ELEMENTS OF THE NITROGEN SUBGROUP. Mironov, K. E. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Mater. Res. Bull., 4: 257-64(Apr. 1969).

Compounds between rare earth metals and the elements of the nitrogen subgroup, referred to as pnictides, are reviewed. Pnictides of the composition LnPn or 1:1 were most completely studied. These rare earth compounds with the pnictogens are expected to have semiconducting or semimetallic properties because of their electronic structure. The synthesis of pnictides is carried out directly from elements or indirectly through their compounds. The preparation of single crystals of refractory compounds is possible through a gas phase reaction including the use of some substances as transporters. The single crystals of lower-melting compounds (antimonides, bismuthides) are grown from a melt by direct fractional crystallization. Complete investigations of the systems rare earth metal–nitrogen and rare earth metal–phosphorus were not carried out. The data obtained here are compared to those known for actinide compounds. All known electrical properties of monopnictides of rare earth metals are given. (BBB)

43302 SURFACE PROCESSES ACCOMPANYING THE DIFFUSION OF ANTIMONY INTO GERMANIUM AS INFLUENCED BY THE NATURAL RADIATION OF THE ^{124}Sb ISOTOPE. Arakelyan, V. S.; Spitsyn, Vikt. I.; Lazarev, V. B. (Inst. of Physical Chemistry, Moscow, Inst. of General and Inorganic Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 187: 116-19(July 1, 1969). (In Russian).

Graphical data based on previous studies showed that during diffusion the distribution of antimony in monocrystalline germanium deviated sharply from that in the surface layers. The concentration of antimony $C_{(s)}$ on the surface exceeded the concentration in germanium by the order of 1 to 3. Previously, it was also shown that the diffusion annealing temperature, the concentration of antimony in the vapor phase, and β- and γ-emission of radioactive ^{124}Sb had a strong influence on the magnitude of $C_{(s)}$. Moreover, a certain similarity was observed in radiation and high-temperature effects. Microphotographic studies of the germanium surface following ^{124}Sb diffusion in argon at 715°C revealed etching pits. It was also observed that during Ge annealing in the presence of antimony vapors the mass transfer increased ~50% in gas media and 10-fold in a vacuum. An increase in the concentration of activated complexes with the increase of the specific radioactivity of ^{124}Sb resulted in intensified mass transfer in media with oxygen and even more intensified diffusion on germanium surfaces during annealing in a vacuum. (R.V.J.)

43303 AQUA COMPLEXES OF CATIONS AS INVESTIGATED BY MEANS OF NUCLEAR MAGNETIC RESONANCE. Buslaev, Yu. A.; Petrosyants, S. P.; Buslaeva, N. M.; Tarasov, V. P. (Inst. of General and Inorganic Chemistry, Moscow). Dokl. Akad. Nauk SSSR, 187: 120-3(July 1, 1969). (In Russian).

Nuclear magnetic resonance studies of complex formation of various diamagnetic cations in hydro-organic solutions of $Be(NO_3)_2$, $Al(ClO_4)_3$, $GaCl_3$, $InCl_3$, $Th(NO_3)_4$, and $UO_2(NO_3)_2$ showed that they form by degrees. The ratio of H_2O/cation as a function of formation of a series of aqua complexes was fixed for each cation. The maximum water coordination for beryllium was four, for aluminum—six, for gallium—five, for indium—three, for thorium—two, and uranyl—three. The temperature dependence of the band width was used for determining the activation energy of molecular exchange in coordinated water. (R.V.J.)

43304 BERYLLIUM ELECTROCHEMICAL BEHAVIOR IN AQUEOUS MEDIA. Shapovalov, E. T.; Gerasimov, V. V. At. Energ. (USSR), 26: 498-502(June 1969). (In Russian).

The electrochemical behavior of pure (99.7%) unpressed beryllium has been investigated by potentiostatic and potentiodynamic methods. Beryllium is passive with a wide range of potentials in neutral, acid, and alkaline media without depassivators (chloride and sulfate ions). The passivity current in neutral media is about 0.1 ma/cm^2, and in 5 N KOH it is 10 ma/cm^2 (most of the experiment has been carried out in this medium). The transpassivity potential in 5N KOH solution is 0,7 v (standard hydrogen electrode). It was proved that the beryllium passivity is not caused by the presence of the oxide phase film. The mechanism of the cathodic reaction is discussed. The anodic reaction of oxygen evolution on passive beryllium proceeds with difficulty. It is assumed that the beryllium passivity is caused by a formation of chemosorption oxygen layer on its surface. (auth)

43305 INVESTIGATION OF VAPORIZATION OF CARBIDE, NITRIDE, AND CARBONITRIDES OF URANIUM. Andrievskii, R. A.; Khromonozhkin, V. V.; Galkin, E. A.; Mitrofanov, V. I. At. Energ. (USSR), 26: 494-8(June 1969). (In Russian).

With the integral variant of the Knudsen method, uranium vapor pressure was determined over uranium carbide of different composition (T = 1900 to 2300°C) as well as over uranium nitride and carbonitride (T = 1600 to 1900°C). The Knudsen cell material effect on the experimental results was investigated; it was found in particular that the tungsten cell used in the determination of uranium carbide vapor pressure can cause considerable overstated results at the expense of the interaction. Values of the formation heat for uranium carbide and nitride were estimated. These values are in good agreement with calorimetric data. Using statistical thermodynamics the effect of the carbide composition on the uranium vapor pressure is discussed. The analysis of vapor pressure variations for carbonitrides showed that the system UC–UN behaved at high temperature as an ideal solution. (auth)

43306 EVIDENCE FOR PSEUDOCONTACT NMR SHIFTS IN U(IV) COMPOUNDS. Siddall III, T. H.; Stewart, W. E.; Karraker, D. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Chem. Phys. Lett., 3: 498-500(July 1969).

PMR spectra were obtained for several U(IV) and thorium compounds. Results indicate that the contact mechanism alone cannot account for shifts due to paramagnetism. Both theory and experiment indicate that the pseudocontact effect must significantly affect the NMR spectra of U(IV) compounds. (J.G.B.)

43307 MASS-SPECTROMETRIC STUDY OF RATE CONSTANTS FOR ADDITION REACTIONS OF H AND D ATOMS WITH cis- AND trans-BUTENES IN DISCHARGE-FLOW SYSTEM AT 300°K. Daby, Eric E.; Niki, H. (Ford Motor Co., Dearborn, Mich.). J. Chem. Phys., 51: 1255-6(Aug. 1, 1969).

The absolute rate constants were determined for the addition reactions of H atoms and of D atoms with cis- and with trans-butene at 300°K by the discharge-flow technique using mass spectrometric detection. The biomolecular rate constants were obtained directly from the exponential decay slopes of cis and trans-butenes in the presence of about 100 times excess of atomic hydrogen using $k = \ln\{[(C_4H_8)_{t_1}/(C_4H_8)_{t_2}]/[(H)(t_2 - t_1)]\}$, where $(C_4H_8)_t$ refers to the butene concentration at reaction time t. Rate constants were determined as a function of all experimental parameters at He diluent pressures of 0.4 to 2.2 torr. Values for k obtained were k(H + trans) = (9.0 ± 0.6); K(H + cis) = (8.1 ± 0.5); k(D + trans) = (7.7 ± 0.2); and k(D + cis) = (6.6 ± 0.4) × 10^{-13} cc/molecule sec. No pressure effect was observed. (D.H.M.)

43308 SECONDARY α-DEUTERIUM ISOTOPE EFFECTS IN THE DIAZETIDINE FORMATION FROM AZODICARBOXYLATES AND VINYL ETHERS. von Gustorf, E. K.; White, D. V.; Leitich, J.; Henneberg, D. (Max-Planck-Institut fuer Kohlenforschung, Mulheim, Ger. Boston Coll., Chestnut Hill, Mass.). Tetrahedron Lett., No. 36, 3113-16(Aug. 1969).

Azodicarboxylates yield diazetidines on reaction with vinyl ethers, and a study was made of the secondary α-deuterium isotope effects on this 2π + 2π cycloaddition reaction, with a view to gaining insight into the mechanism. The following conclusions were drawn: (1) deuterium substitution at CH_2= accelerates the formation of diazetidines by $k_D/k_H \approx 1.21$ per deuterium; (2) deuterium substitution at =CH(OR) decreases the rate of deazetidine by $k_D/k_H \approx 0.89$; (3) change of hybridization in the direction sp^2 to sp^3 occurs in the transition state at CH_2=, but not at =CH(OR). A picture is derived for the transition state of the diazetidine formation from azodicarboxylates and vinyl ethers as a two-step reaction. (UK)

43309 INTRAMOLECULAR KINETIC ISOTOPE EFFECT IN THE ACID DECOMPOSITION OF CARBONATES. Sharma, S. K.; Sharma, T. (Indian Inst. of Tech., Kanpur). J. Mass Spectrom. Ion Phys., 2: 485-93(June-July 1969).

The ^{18}O intramolecular kinetic isotope effect associated with the phosphoric acid decomposition of carbonates was studied over the temperature range of 25 to 62°C. The k_1'/k_2' ratio, which measures the isotope effect, lies in the range 1.0163 to 1.0145, 1.0151 to 1.0134, 1.0154 to 1.0138, and 1.0163 to 1.0147 for $CaMg(CO_3)_2$, $CaCO_3$, $SrCO_3$, and $BaCO_3$ respectively. The isotope effect decreases with increase in temperature. The Temperature Independent Factor (TIF) was found to be 0.9981, 1.000, 1.002, and 1.003 for $CaCO_3$, dolomite, $SrCO_3$, and $BaCO_3$ respectively. The difference in the TIF values for various carbonates is correlated with the atomic weight of the metal in MCO_3. (auth)

43310 EXPERIMENTS ON THE CHEMISTRY OF ELEMENT 104: KURCATOVIUM. II. CHEMICAL INVESTIGATION OF THE SPONTANEOUSLY FISSIONING ISOTOPE WITH A HALF-LIFE OF 0.3 SECONDS. Zvara, I.; Chuburkov, Yu. T.; Tsaletka, R.; Shalaevskii, M. R. Radiokhimiya, 11: 163-74(1969). (In Russian).

The adsorptive properties of chlorides of Element 104 were compared with those of chlorides of elements of Groups III and IV. The independent chemical identification of the 0.3-sec isotope of Element 104 was accomplished. Chemical properties of Element 104 show that it is the analog of hafnium and must be placed in the IVb Group of the periodic table. (tr-auth)

43311 APPLICATION OF ALKYLAMMONIUM SALTS FOR DISSOLUTION OF INORGANIC COMPOUNDS. VI. DISSOLUTION OF $U(C_2O_4)_2 \cdot nH_2O$ IN SOLUTIONS OF TRIDECYLAMMONIUM FLUORIDE. Nikitina, S. A.; Lipovskii, A. A. Radiokhimiya, 11: 187-93(1969). (In Russian).

Fluorooxalate complexes of U(IV) showed the possibility of obtaining complex compounds with diverse acidic ligands in the coordination sphere by dissolution of neutral simple salts in solutions of alkylammonium salts with other acidic ligands. On dissolution of $U(C_2O_4)_2 \cdot nH_2O$ in solutions of tridecylammonium fluoride in CCl_4, the compounds $(TDAN)_3U(C_2O_4)_2F_3$ and $(TDAN)_3U(C_2O_4)_3F$ were formed. The electronic and infrared spectra of these compounds were measured and their molecular weights determined. In both compounds oxalate groups were bidentately coordinated to atoms of uranium. (tr-auth)

43312 OXALATE COMPOUNDS OF HEXAVALENT NEPTUNIUM. Mefod'eva, M. P.; Krot, N. N.; Smirnova, T. V.; Gel'man, A. D. Radiokhimiya, 11: 193-200(1969). (In Russian).

On the basis of spectrophotometric measurements, it is shown that on addition of oxalic acid to acid solutions with low concentrations of Np(VI), the complex $NpO_2C_2O_4^0$ is formed. Its stability constant is (1.0 ± 0.2) × 10^6 (μ = 1.0 for $HClO_4$ and t = 20°C). In weakly acid media in the presence of excess oxalic acid a complex with two oxalate groups, $NpO_2(C_2O_4)_2^{2-}$, is formed. Its stability constant at μ = 1.0 for NH_4NO_3 and t = 13°C is (1.2 ± 0.4) × 10^4. $NpO_2C_2O_4 \cdot 3H_2O$ was isolated in the form of a solid compound and its solubility in mixtures of HNO_3 and $H_2C_2O_4$ was determined. The solubility product of neptunyl oxalate at μ = 1.0 for HNO_3 and t = 14°C was found to equal 2.3 × 10^{-9}. (tr-auth)

43313 INVESTIGATION OF COMPLEX FORMATION BY THE METHOD OF DIALYSIS. IV. CALCULATION OF EQUILIBRIUM CONSTANTS ON SIMULTANEOUS EXCHANGE OF SEVERAL PARTS OF THE LIGAND. Nikol'skii, B. P.; Posvol'skii, M. V.; Lyubtsev, R. I. Radiokhimiya, 11: 221-6(1969). (In Russian).

A method based on dialysis was developed for calculation of equilibrium constants for simultaneous entry into the coordination sphere of complex ions of several ligands. The first stage of hydrolysis of uranyl triacetate proceeds with the displacement of one acetate hydroxyl ion. The value of the equilibrium constant for the first-stage hydrolysis of uranyl triacetate was determined and the values for the second and third stages evaluated. (tr-auth)

43314 FORMATION OF POLYMER COMPOUNDS BY URANYL NITRATE IN TRIBUTYL PHOSPHATE EXTRACTS. Nemodruk, A. A.; Karyakin, A. V.; Muradova, G. A. Radiokhimiya, 11: 229-32(1969). (In Russian).

Uranyl complexes in tributyl phosphate extracts, saturated with uranyl nitrate at 20°C, and also in mother liquors, which are formed by cooling tributyl phosphate extracts saturated at 100°C, were studied. It was established that in the mother liquor the amount of ligands necessary on one molecule of uranyl nitrate is insufficient for achievement of coordination saturation of uranyl ions, resulting in the formation of the polymer complexes. Infrared studies were carried out and the possible structure of the polymer complex is discussed. (tr-auth)

43315 SOLVOLYSIS OF URANYL NITRATE IN ALCOHOL SOLUTIONS IN THE PRESENCE OF TRIS(DECYL)AMINE. Vdovenko, V. M.; Ladygin, I. N.; Suglobova, I. G.; Suglobov, D. N. Radiokhimiya 11: 236-9(1969). (In Russian).

On the interaction of uranyl nitrate with tridecylamine in methanol, an insoluble uranyl methylate is formed, which loses molecules of alcohol on heating in a vacuum. An analogous solvolysis reaction proceeds in butanol and hexanol, but in these cases the compounds formed are soluble in excess solvent. (tr-auth)

43316 INVESTIGATION OF THE COMPLEX FORMATION OF Np(IV) WITH FLUORINE IONS IN HNO_3 SOLUTIONS BY THE METHOD OF IONIC EXCHANGE. Krylov, V. N.; Komarov, E. V.; Pushlenkov, M. F. Radiokhimiya, 11: 244-5(1969). (In Russian).

By the method of cation exchange in solutions of HNO_3 containing (0.7 to 328) × 10^{-5} mol/l HF and 1.51 × 10^{-5} g-ion/l Np(IV), the existence of the complex NpF^{3+} was shown. Formation constants of (1.3 ± 0.1) × 10^4 and (1.7 ± 0.4) × 10^4 were obtained in 2 and 1M HNO_3, respectively. (tr-auth)

43317 REACTION OF THORIUM TUNGSTATE WITH THE TUNGSTATES OF SODIUM AND LITHIUM. Trunov, V. K.; Bushuev, N. N. Radiokhimiya, 11: 245-7(1969). (In Russian).

The reactions of the tungstate and molybdate of thorium with the tungstates and molybdates of lithium and sodium were studied. X-ray analyses indicated the formation of the compounds $Na_4Th(WO_4)_4$ and $Na_2Th(WO_4)$ in the system $Na_2WO_4 - ThW_2O_8$. On the interaction of lithium tungstate with thorium tungstate, the compound $Li_2WO_4 \cdot nThW_2O_8$, where $3 \leq n \leq 4$, is formed. Analogous compounds are obtained on the interactions of sodium and lithium molybdates with thorium molybdate. (M.C.G.)

43318 ISOTOPE EFFECTS. Wolfsberg, Max (Brookhaven National Lab., Upton, N. Y.). Annu. Rev. Phys. Chem., 20: 449-78(1969).

A limited review on literature published since 1956 and dealing with isotope effects is presented. The following topics are discussed: effects on equilibrium constants; and, isotope effects on chemical processes, which include simple gas phase reactions, the Westheimer effect, secondary isotope effects, heavy atom isotope effects, and tunneling in organic reactions. Energy transfer and amplitude isotope effects are also discussed. (216 references) (J.G.B.)

43319 RADII OF MONOVALENT CRYSTALLINE RARE EARTH ELEMENTS AND THEIR THERMOCHEMICAL APPLICATIONS. Finogenov, A. D. (Leningrad Inst. of Semiconductors). Zh. Fiz. Khim., 43: 2111-13(Aug. 1969). (In Russian).

The radii of monovalent crystalline rare earth elements were calculated and relations were obtained for enthalpy of rare earth formation as a cation function and anion polarization energy. It was found that the thermodynamic data for the rare earths with f-electrons differ from the La and Y compounds and do not depend on the cation and anion forces. Tabulated data are given for the radii of various monovalent metallic and crystalline elements. (R.V.J.)

43320 PRESSURE OF SATURATED VAPOR FOR HOLMIUM, THULIUM, AND LUTETIUM CHLORIDES. Dudchik, G. P.; Polyachenok, O. G.; Novikov, G. I. (Minsk Technological Inst.). Zh. Fiz. Khim., 43: 2145(Aug. 1969). (In Russian).

The pressure of saturated vapor of anhydrous Ho, Te, and Lu chlorides was measured by a method of boiling point in the temperature range from 1000 to 1370°C. Thermodynamic data on chloride evaporation are tabulated. (R.V.J.)

43321 THE DEPENDENCE OF KINETIC ISOTOPE EFFECTS ON THE FREE ENERGY CHANGE FOR PROTON TRANSFER REACTIONS. Matthews, D. B. (Research and Development Labs., Rhodes, Australia). Aust. J. Chem., 22: 463-4(Feb. 1969).

It was previously reported that in the use of kinetic isotope effects to determine the mechanism of proton transfer reactions, cancellation of proton tunneling and of the symmetric stretching mode may occur. It is now shown to occur only in special circumstances. Both factors depend on the electrochemical free energy change of the proton transfer step, and although the sign of the dependence is identical, one factor tends to increase the magnitude of the isotope effect and the other tends to decrease it. (Australia)

43322 ANNUAL REVIEW OF PHYSICAL CHEMISTRY. VOLUME 20. Erying, H.; Christensen, C. J.; Johnston, H. S. (eds.). Palo Alto, Calif., Annual Reviews, Inc., 1969. 527p. $8.50.

Chapters on the following topics are included: fifty years of physical chemistry in Great Britain; topics in Moessbauer spectroscopy; elementary gas reactions; electrochemistry; solutions of nonelectrolytes; microwave spectroscopy; theories of liquids; intermolecular forces; electron spin resonance; shock tube technique in chemical kinetics; vibrational spectroscopy; quantum theory of structure and dynamics; electronic spectroscopy by electron spectroscopy; and, optical activity. Separate abstracts have been prepared for chapters on cosmochemistry, quantum theory of structure and dynamics, and isotope effects. Author and subject indexes are included. (J.G.B.)

For abstracts of individual papers see: 43318, 43323, and 44576.

43323 COSMOCHEMISTRY. Arnold, James R.; Suess, Hans E. (Univ. of California, San Diego, La Jolla). Annu. Rev. Phys. Chem., 20: 293-314(1969).

The present state of knowledge of the chemical composition of our solar system as a whole, and of the various chemical fractionation processes that might have been important during its formation, is reviewed. Information on the chemical and isotopic composition of meteorites, comets, the planets and satellites, and the sun is included. Various concepts of cosmochemistry are set forth. (97 references) (J.G.B.)

43324 STUDY OF THE KINETICS OF ISOTOPIC EXCHANGE BY THE CENTRAL ATOM IN THE SYSTEM Ph_2Te–Ph_2TeCl_2–$CHCl_3$. Nefedov, V. D.; Sinotova, E. N.; Sarbash, A. N.; Timofeev, S. A. Radiokhimiya, 11: 254-6(1969). (In Russian).

The fact of isotopic exchange by the central atom in the system $Ph_2TeCl_2 - Ph_2Te - CHCl_3$ was established. The activation energy and kinetics of the exchange were determined. (tr-auth)

43325 EXPERIMENTS ON THE CHEMISTRY OF ELEMENT 104: KURCATOVIUM. I. THE DEVELOPMENT OF A METHOD FOR THE STUDY OF SHORT-LIVED ISOTOPES. Zvara, I.; Chuburkov, Yu. T.; Zvarova, T. S.; Tsaletka, R. Radiokhimiya, 11: 154-62(1969). (In Russian).

A method was studied for the continuous separation of short-lived products of nuclear reactions, based on gas chromatography of their anhydrous chloride compounds. Hafnium was separated from Group III elements in a time on the order of 0.1 sec. The possibility of the utilization of this method for identification of Element 104, if this element is ekahafnium, is shown. (tr-auth)

43326 EXPERIMENTS ON THE CHEMISTRY OF ELEMENT 104: KURCATOVIUM. III. CHEMICAL EQUIPMENT IN THE CYCLOTRON BEAM. Chuburkov, Yu. T.; Zvara, I.; Shilov, B. V. Radiokhimiya, 11: 174-87(1969). (In Russian).

The working principles and design peculiarities of chemical equipment operating in the internal cyclotron beam of multiply charged ions are described. The physicochemical conditions for studies on the chemical properties of Element 104 are discussed. (tr-auth)

43327 INVESTIGATION OF SALT SYSTEMS UO_2Cl_2–NaCl AND UO_2Cl_2–KCl. Vorobei, M. P.; Skiba, O. V.; Kapshukov, I. I.; Desyatnik, V. N.; Yakovlev, G. N. At. Energ. (USSR), 27: 121-4(Aug. 1969). (In Russian).

Using DTA and x-ray diffraction methods the following binary salt systems have been investigated: $NaCl - UO_2Cl_2$($2NaCl \cdot UO_2Cl_2$, $NaCl \cdot 2UO_2Cl_2$ and $NaCl \cdot 3UO_2Cl_2$ are formed peritectically; their decomposition temperature is 327, 370, 420°C; the eutectic is at the temperature of 310°C and 42.5 mole % UO_2Cl_2) and $KCl - UO_2Cl_2$($2KCl \cdot UO_2Cl_2$ and $KCl \cdot 2UO_2Cl_2$ melt congruously at the temperature of 355 and 512°C; $3KCl \cdot 2UO_2Cl_2$ is formed peritectically; its decomposition temperature is 410°C; the eutectics are at the temperature of 330, 300, 496°C and 29.0, 40.0 and ≈72.5 mole % UO_2Cl_2). The liquidus surface of the $NaCl - KCl - UO_2Cl_2$ system has been represented. (auth)

43328 ORGANOMETALLIC π-COMPLEXES. XVIII. PROTON NUCLEAR MAGNETIC RESONANCE ANALYSIS OF SOME DEUTERATED FERROCENES. Rausch, M. D.; Siegel, A. (Univ. of Massachusetts, Amherst). J. Organometal. Chem. (Amsterdam), 17: 117-25(Apr. 1969).

A series of 2,5-dideuterated, monosubstituted ferrocene compounds was prepared. The first compound, 2,5-dideuterio[(dimethylamino)methyl]ferrocene, was prepared by treating the unlabeled [(dimethylamino)methyl]ferrocene (81 g, 0.33 mole) in ether with 0.50 mole of n-butyllithium in hexane under nitrogen, and D_2O was added. A second treatment gave 97% of 88% dideuterated compounds. Other deuterated ferrocene compounds, where the side group is $CH_2N(CH_3)_2$, $CH_2N(CH_3)_3I$, $CH_2P(C_6H_5)_3I$, $CH=C(C_6H_5)_2$, CH_3, CHO, $C(O)CH_3$, $C(Cl)=CHCHO$, $CH=CH_2$, $C\equiv CH$, and $C\equiv CC_6H_5$, were prepared from this. A comparison of the proton NMR spectra of these deuterated products with the spectra of their nondeuterated derivatives permitted the unequivocal assignment of proton resonance frequences in the latter series. The NMR spectra of the deuterated compounds are illustrated and the effect of D labeling on the spectra discussed. The data confirm earlier assignments, where the 2,5 positions were usually claimed to give the lower field resonance of the 2 pairs. (BBB)

43329 NOVEL COMPLEXES OF URANIUM(V). Selbin, J.; Ahman, N.; Pribble, M. J. (Louisiana State Univ., Baton Rouge). J. Chem. Soc., D, No. 13, 759-60(1969).

Several new complexes of formally quinquevalent uranium, all but one of which have the general formula UCl_3L_x, were synthesized (the donor atoms in the organic ligands being N, P, As, S, Se, and Te). ESR evidence suggested that the lone U^V electron is strongly delocalized on to the unsaturated organic moiety, perhaps into π-antibonding MO's. (auth) (UK)

43330 VIBRATIONAL ASSIGNMENTS AND POTENTIAL CONSTANTS FOR cis- AND trans-1,2-DIFLUOROETHYLENES AND THEIR DEUTERATED MODIFICATIONS. Craig, Norman C. (Oberlin Coll., Ohio); Overend, John. J. Chem. Phys., 51: 1127-42(Aug. 1, 1969).

Infrared and Raman spectra and a complete assignment of vibrational fundamentals are presented for cis- and trans-1,2-difluoroethylenes and their deuterated modifications. For cis-CFHCFH the fundamentals are: (a_1) 3122, 1716, 1263, 1015, 237; (a_2) 839, 495; (b_1) 3136, 1374, 1130, 769; and (b_2) 756 cm^{-1}. For trans-CFHCFH the fundamentals are: (a_g) 3111, 1694, 1286, 1123, 548; (a_u) 875, 329; (b_g) 788; and (b_u) 3114, 1274, 1159, 341 cm^{-1}. The near degeneracy in ν_7 and ν_{12} of the trans isomer is shown from low-temperature crystal and matrix studies and zero-order normal coordinate calculations. Analysis of the rotational structure in the region of the overlapped bands proved that these fundamentals are strongly perturbed by Coriolis coupling. From the vibrational fundamentals and a previous measurement of ΔH^0_{298}, the cis isomer was found to have 1086 cal/mole less electronic energy than the trans isomer. For the in-plane vibrations refined Urey–Bradley

potential constants are presented. These constants were obtained from an overlay calculation involving the full set of six molecules. For the out-of-plane vibrations, refined general valence constants, obtained for the separate isomers, are presented. (auth)

43331 STRUCTURE OF SOME URANIUM(IV) CHELATES IN SOLUTION. Siddall, T. H.; Stewart, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Chem. Soc., D, No. 16, 922-3(1969).

NMR data in solution indicate that acetylacetonatouranium(IV) and related compounds have a less symmetrical structure than a D_2 square antiprism or a D_{2d} triangular dodecahedron. (auth) (UK)

43332 THERMODYNAMICS OF LITHIUM ISOTOPE EXCHANGE REACTIONS. I. ELECTROCHEMICAL INVESTIGATIONS IN DIGLYME AND PROPYLENE CARBONATE. Hall, John C.; Murray, Richard C. Jr.; Rock, Peter A. (Univ. of California, Davis). J. Chem. Phys., 51: 1145-7(Aug. 1, 1969).

A direct experimental determination of the equilibrium constant for the isotope exchange reaction, $^7Li(s) + {}^6LiBr(soln) = {}^6Li(s) + {}^7LiBr(soln)$ has been made using an electrochemical cell without liquid junction. The value obtained is $K = 1.037 \pm 0.004$ at 23°C in diglyme as solvent. The value obtained has been compared with values calculated from statistical thermodynamic theory. (auth)

43333 THERMAL STABILITY OF METAL HYDRIDES, DEUTERIDES: AND TRITIDES. Jones, P. M. S. (Ministry of Technology, Chilton, Eng.); Ellis, P.; Aslett, T. Nature (London), 223: 829-30(Aug. 23, 1969).

There is an interest in the stability of metal hydride materials in view of their potential use as nuclear reactor moderators and as target materials in neutron generators. Earlier studies on the thermal stability of rare earth and Y dihydrides and dideuterides gave discordant results. A method involving measurements of the isotopic separation in a mixed deuterium–tritium system was adopted, and the metals studied were Er, Tl, and U. The results confirmed the theoretical treatment adopted in a study of hydrogen/deuterium isotope fractionation in the uranium hydride/hydrogen system by Bigeleisen and Kant (J. Amer. Chem. Soc. 76: 5957 (1954)). Details of the experimental procedure are described; mass spectrographic analysis was employed. The effects of atomic ratio, isotopic ratio, and temperature were investigated. Results are tabulated. The isotopic separation data can be used to calculate dissociation pressures for unknown isotopic ratio hydrides. (UK)

43334 ORGANIC REAGENTS USED IN INORGANIC ANALYSIS. V. DETERMINATION OF FORMATION CONSTANTS OF URANIUM(VI) CHELATES WITH SEVERAL HYDROXAMIC AND N-ARYLHYDROXAMIC ACIDS. Dutt, N. K.; Seshadri, T. (Indian Association for the Cultivation of Science, Calcutta). J. Inorg. Nucl. Chem., 31: 2153-7(July 1969).

The formation constants of uranium(VI) chelates with six N-arylhydroxamic acids and three hydroxamic acids were determined by a pH-potentiometric method. Solubility products of the complexes were also determined, from which it appears that the reagents can be utilized for the gravimetric determination of uranium(VI). (auth) (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 43384 and 44780.

43335 (CONF-690605-4) RADIATION-INDUCED GRAFTING OF STYRENE TO POLYETHYLENE. Machi, Sueo; Silverman, Joseph (Maryland Univ., College Park. Lab. for Radiation and Polymer Science). [1968]. 20p. Dep. CFSTI.

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

Grafting experiments have been performed on styrene over a range of gamma dose rates from 10^3 to 3×10^5 Rad/hr using polyethylene in film and single crystal form, as well as ethylene–propylene rubber. Data were obtained on the kinetics of covalent grafting, the formation of occluded homopolymer, and bubble characteristics as a function of irradiation and soaking conditions. Bubble formation was found to be a sensitive function of soaking conditions. A polyethylene film sample irradiated at 10^5 Rad/hr for 5 hours showed a weight gain of 51% after a five minute soak in benzene. Aside from a slight increase in opalescence, no bubbles could be observed using ordinary methods of optical microscopy. The time threshold for bubble formation was 10.8 hr by which time the net weight gain of the film was 42%; up to this point, the film was an almost homogeneous blend of the matrix, the occluded homopolymer, and the covalent graft. After a 180 hr soaking, the film was pockmarked with many large bubbles, and showed a weight gain of 31% of which only half was the covalent graft. The films that were not subjected to prolonged extraction procedures showed increased tensile strength and modulus, and decreased elongation. The covalent grafting of ethylene–propylene rubber followed a quasi-homogeneous stationary state model in which all the radicals formed in the polyolefin form graft chains. Polyethylene crystals grafted about twice as rapidly at all dose rates. Covalent grafting rate to films increased with density; viscosity effects in the amorphous region are suggested as the cause of this anomaly. (P.C.H.)

43336 (COO-1043-3) RADIATION CHEMISTRY OF ORGANIC COMPOUNDS. Final Report, June 1, 1968–May 31, 1969. Yang, N. C. (Chicago Univ., Ill. Dept. of Chemistry). Contract AT(11-1)-1043. 6p. Dep. CFSTI.

Developments are reported for studies on: photochemistry of polyhalomethanes; attempted generation of tropylium and related systems by radiochemical methods; and charge-transfer interactions in organic polymers and organic semiconductors. (P.C.H.)

43337 (COO-1618-12) COMPUTER SIMULATION OF HOT-ZONE REACTIONS. II. Anselmo, Vincent C.; Rekart, Linda (New Mexico Highlands Univ., Las Vegas). [1969]. Contract AT(11-1)-1618. 4p. Dep. CFSTI.

HP and HPH, for recoil ^{32}P produced in $NH_4H_2PO_2$, were considered the recoiling species. The following ratio of atoms and species was used: HP : HPH : N : H : O :: 59 : 59 : 118 : 528 : 236, and then these were distributed randomly in a $10 \times 10 \times 10$ matrix. The atoms and species were moved randomly within the matrix in a stepwise manner. After each step the computer was asked to print out the new matrix. The procedure was repeated 10 times. Results from computer simulation were compared with experimental results. (M.C.G.)

43338 (COO-1763-12) [PULSE RADIOLYSIS STUDIES OF FAST REACTIONS IN MOLECULAR SYSTEMS]. [Annual Progress Report]. Dorfman, Leon M. (Ohio State Univ., Columbus. Dept. of Chemistry). Aug. 19, 1969. Contract AT(11-1)-1763. 5p. Dep. CFSTI.

The kinetics of the reactions of formation, decay, and charge transfer from neutral molecules were studied for molecular cations of compounds such as diphenyl, p-terphenyl, pyrene, and anthracene in 1,2-dichloroethane. The data for the rate of formation of the aromatic cation by charge transfer from the positive charge (RCl^+) in the solvent: $RCl^+ + A = RCl + A^+$ suggest that this process may be a rapid hole migration, rather than a diffusion of the molecules in RCl^+. The fast detection of hydrogen atoms by Lyman-α resonance absorption spectroscopy (1216 Å) was successfully combined with the pulse radiolysis method and was applied to a study of the gas phase reaction $H + O_2 + M = HO_2 + M$, where $M = H_2$. Observations indicate that in pure hydrogen the formation of H-atoms in the ground state is complete within a few microsecs. Data give $K_{H+O_2} = (2.0 \pm 0.5) \times 10^{19}\ M^{-2}\ sec^{-1}$ with H_2 as the third body at approximately 35°C. The spectra and kinetics of the solvated electron in liquid ammonia and amine systems were also investigated. The effects of the solvents (cyclohexane and ethylenediamine) on the proton transfer reaction $diphenyl^- + C_2H_5OH = diphenyl\ H^* + C_2H_5O^-$ were studied. (D.H.M.)

43339 (JUL-563-PC) ON γ RADIOLYSIS OF CARBON MONOXIDE-METHANE MIXTURES. Borger, W. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Dec. 1968. 39p. (In German). Dep. CFSTI (U. S. Sales Only).

The γ-radiolysis of CO–methane mixtures in the gas phase, yielded as the chief products, H_2, ethane, ethylene, acetylene, propane, butane, isobutane, formaldehyde, acetaldehyde, acetone, butanone, and 2,3-butanedione. For some of these compounds, their G-values were calculated in relation to the concentrations of the CO and methane and the absorbed dose. Mechanisms of formation of ethane, acetone, acetaldehyde, and 2,3-butanedione are discussed. (tr-auth)

43340 RADIATION-INDUCED ELECTRICAL CONDUCTANCE IN THE LIQUIDS ARGON, NEOPENTANE, AND n-HEXANE: THE INFLUENCE OF ELECTRON LOCALIZATION EFFICIENCY ON THE FREE-ION YIELD. Tewari, P. H.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 51: 1276-9 (Aug. 15, 1969).

An extra electron in liquid argon does not form a localized state. The free-ion yield in liquid argon is $G(e^-)_{fi} \approx 5$, which indicates that all the ion–electron pairs formed during the x radiolysis of argon become free ions. The difference between the values of G_{fi} in neopentane (0.9) and n-hexane (0.13) is due to the smaller efficiency of electron localization in the former than in the latter liquid. The efficiency of electron localization is a function of the geometry of the hydrocarbon molecule. (auth)

43341 EFFECT OF ELECTRON SCAVENGERS ON THE POSITIVE ION REACTIONS IN THE RADIOLYSIS OF CYCLOPROPANE SOLUTIONS. Rzad, Stefan J.; Schuler, Robert H. (Mellon Inst., Pittsburgh). J. Chem. Phys., 51: 1369-75(Aug. 15, 1969).

Electron scavengers such as CCl_4, SF_6, N_2O, and CH_2Br are found to increase the yield of the secondary positive ion reactions that occur in the radiolysis of cyclopropane solutions in cyclohexane. The observed increase can be understood in terms of an increase in the lifetime of the ion pairs that results when the electron initially formed is converted to a less mobile negative ion. The quantitative aspects can be treated in terms of the change in the mutual diffusion coefficient of the ion pair if in the model the concentration dependence is included for ion scavenging found when only one solute is present. Electron capture by CCl_4 is found to result in a decrease in the diffusion coefficient of the ions by a factor of 17. From this and available experimental information on the diffusion coefficients of positive and massive negative ions the diffusion coefficient of the negative entity initially produced by the radiation in cyclohexane is estimated as 2.6×10^{-4} cm^2 sec^{-1}. This diffusion coefficient is considerably higher than those for the massive negative ions so that there seems to be little question but that the electron is involved in a more or less free state. The absolute rate constant for the electron scavenging process is estimated to be of the order of magnitude of 10^{11} M^{-1} · sec^{-1} and that for the positive ion reactions of cyclopropane a factor of 30 smaller. (auth)

43342 RADIATION CHEMISTRY OF FOODS. PART 2. REACTIVITY OF SOME FOOD CONSTITUENTS WITH A MODEL SECONDARY RADICAL, CH_2OH. Morita, Makio; Tajima, Makoto (Tokyo Univ.). Agr. Biol. Chem. (Tokyo), 33: 250-5(Feb. 1969).

An intermediate radical, $\dot{C}H_2OH$, was produced in an aqueous methanol solution containing nitrous oxide by γ-irradiation. Yields of ethylene glycol and formaldehyde, the major and the minor product from $\dot{C}H_2OH$, respectively, changed on the addition of some solutes. Cysteine lowered both product yields to zero even at a low concentration of 5×10^{-5} M. Oxygen of low concentrations (2.5 to 7.5×10^{-4}M) changed effectively the major product from ethylene glycol to formaldehyde. $k_{(CySH+\dot{C}H_2OH)}/k_{(O_2+\dot{C}H_2OH)}$ was calculated as 0.5. Ascorbic acid (5×10^{-4}M) lowered ethylene glycol yield to 48%. A concentration of 10^{-3} M of the following compounds lowered the ethylene glycol yield to the indicated % values of the control: cystine, 15%; methionine, 31%; histidine, 42%; tryptophan, 46%; tyrosine, 77%; phenylalanine, 73%; hypoxanthine, 37%; adenine, 52%; uracil, 20%; thymine, 10%; cytosine, 49%; rutin, 23%; pyrogallel, 41%; and gallic acid 78%. These results suggest that the reactions of the secondary radicals such as CH_2OH perform an important role in material change of food irradiated with γ rays. (NSA of Japan)

43343 METHOD FOR PRODUCING HEAT-RESISTING POLYETHER. Fukui, Kenichi (to Sumitomo Chemical Co.). Japanese Patent 1969-11381. May 26, 1969. Filed Apr. 13, 1964.

Formaldehyde is polymerized in the presence of carboxylic anhydride, with or without CO_2, to yield a heat-resistant polyether by irradiation of the reacting materials with ionizing radiation. Formaldehyde may be the one obtained by pyrolyzing α-polyoxymethylene, and then it is dried with silica gel. As the carboxylic anhydride, either aromatic organic acid or organic acid may be used, singly or in combination. (NSA of Japan)

43344 USE OF RADIATION EFFECTS IN CHEMISTRY. Ionescu, G.; Negulescu, R. Inform. Doc. Selec., Tehn. Nucl., 12: 243-51(Mar. 1969). (In Rumanian).

A brief review is given on the development of radiation chemical processes. Radiation mechanisms applied to the manufacturing processes of hydrazine, studies of organic substances, biology, catalytic activity, and industrial processes are discussed. The radiation chemistry of polymeric systems nuclear radiation effects on the electrical properties of epoxy resins, metal corrosion, and radiation in textiles and other technological and industrial processes is reviewed. 96 references. (R.V.J.)

43345 PRODUCTION OF ^{11}C AND ^{7}Be BY TRIGA-II RESEARCH REACTOR. Maruyama, Yoshiaki; Manri, Teruo; Komiya, Kazuhide (Musashi Inst. of Tech., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 474-7(Aug. 1969).

^{11}C was produced by irradiating for 30 min in the pneumatic tube of a TRIGA-II research reactor about 700 mg of metaboric acid (HBO_2), using the $^{11}B(p,n)^{11}C$ reaction initiated by neutron-hydrogen recoil. The fast neutron flux (>1 MeV) was 9×10^{11} n/cm^2 · sec. The ^{11}C produced was separated from the irradiated target by distillation of CO_2. The yield of ^{11}C at the end of irradiation was 0.27 μCi. ^{7}Be also was produced by irradiating for 15 hr 1 g of lithium hydroxide in the central experimental tube of the reactor, through the $^{7}Li(p,n)^{7}Be$ reaction initiated by neutron-hydrogen recoil. The fast neutron flux was 2.2×10^{12} n/cm^2 · sec. Separation of carrier-free ^{7}Be from the irradiated target was obtained by co-precipitation with ferric hydroxide. The yield of ^{7}Be was 0.2 μCi. For determining the influence on the ^{7}Be yield brought by differences in the chemical composition of target, irradiations were carried out on lithium compounds containing hydrogen, such as lithium hydroxide, lithium hydroxide hydrate, lithium acetate, and lithium citrate. Among these four lithium compounds, lithium hydroxide provided the highest yield of ^{7}Be per gram of target. (auth)

43346 RADIOCHEMICAL POLYMERIZATION OF THE SULFIDE OF CYCLOHEXENE IN THE LIQUID PHASE. Boileau, Sylvie; Muller, Jean-Claude (CNRS, Paris. Centre d'Etudes et de Recherches des Charbonnages, Creil, France). Compt. Rend., Ser. C, 268: 2284-7(June 30, 1969). (In French).

The radiochemical polymerization of extremely pure cyclohexene sulfide (7-thiabicyclo[4.1.0]heptane) was studied in the liquid state. The rate of polymerization is proportional to the intensity of the radiation, and the molecular masses of the polymers obtained are independent of the intensity. These results favor an ionic mechanism. (tr-auth)

43347 THE PREPARATION OF ^{151}Gd FOR MOESSBAUER SPECTROMETRY OF ^{151}Eu. Bullock, R. J. (Atomic Energy Research Establishment, Harwell, Eng.); Large, N. R.; Jenkins, I. L.; Wain, A. G.; Glentworth, P.; Newton, D. A. J. Inorg. Nucl. Chem., 31: 1929-34(July 1969).

Gadolinium-151 was prepared by bombardment of isotopically enriched $^{151}Eu_2O_3$ (99.15% ^{151}Eu, 0.85% ^{153}Eu) with 16-MeV deuterons. The ^{151}Gd was chemically isolated from the target material by solvent extraction with di(2-ethylhexyl) orthophosphoric acid and further purified by an ion exchange procedure. A comparison was made between the yields of ^{151}Gd produced by deuteron and proton irradiations. (auth) (UK)

43348 INVESTIGATION OF WOOD-SYNTHETIC MATERIAL COMBINATIONS AND OF THE PRODUCTION OF CROSSLINK POLYETHYLENE IN THE HUNGARIAN PEOPLE'S REPUBLIC. Dobo, Janos; Czvikovszky, Tibor; Kalman, Ivan; Somogyi, Agnes (Muanyagipari Kutato Intezet, Budapest). Atomtech. Tajek., 11: 641-6(Dec. 1968). (In Hungarian).

Experiments with wood–synthetic material combinations are aimed at the production of special choice wooden materials by way of impregnating different kinds of hard wood with polyester resin. Successful experiments were performed with the radiation cross-linking of polyethylene to produce heat-resistant polyethylene insulating foils, paddings for chemical industry, and electric insulators. Polyethylene tubes, cross-linked with 10 to 15 MRad, when widened with a 300% shrinkage, still show a considerable shrinkage pressure. (auth)

43349 EXPERIMENTAL STUDY OF THE EFFECT OF WATER VAPOR ON THE IONIZATION PRODUCED IN AIR. Nistel, Marie-Therese (Bureau International des Poids et Mesures, Sevres, France). Compt. Rend., Ser. B, 268: 1650-3(June 23, 1969). (In French).

Measurements made in air containing variable quantities of water vapor show an unforeseen increase of ionization when the proportion of vapor rises from 0 to several thousandths. This could be due to an abnormally rapid decrease in W, the energy necessary for producing an ion pair in air, when small quantities of water vapor are added to dry air. (tr-auth)

43350 IRRADIATION METHOD FOR PRODUCING AND INCREASING YIELD OF 2,2'-BITHIENYL, 2,3'-BITHIENYL AND 3,3'-BITHIENYL FROM THIOPHENE. Berk, Sigmund (to U. S. Navy). U. S. Patent 3,454,480. Filed May 24, 1965.

A process for increasing yields of 2,2'-bithienyl, 2,3'-bithienyl, and 3,3'-bithienyl from liquid thiophene consists of irradiation of the thiophene with high energy radiation in the presence of inorganic substrates, e.g., Al_2O_3. The thiophene–Al_2O_3 mixture is placed in a container; and the container is evacuated, sealed, and heated prior to irradiation. (Offic. Gaz.)

43351 RELEASE OF NITROGEN BY HYDROGEN ON THE IRRADIATED SURFACE OF SILICA GELS. Ablyaev, Sh. A.; Alimova, L. Ya. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 63-4(1968). (In Russian).

Studies were made on the nitrogen release from various types of silica gels during hydrogen desorption. It was found that irradiation of silica gels in a vacuum without hydrogen adsorption did not release nitrogen. A rise in temperature increased the nitrogen release. However, continuous heating of silica gel at 320 to 340°C reduced the amount of nitrogen released. The amount of nitrogen

released depended, significantly, on the grain size of the silica gel; the finer the grain size the more nitrogen was released. Similar data are given for silica gels irradiated by ^{60}Co γ rays at a dose of 2 mR. (R.V.J.)

43352 DETERMINATION OF THE CONSTANTS $Q_{tr}-e_{tr}$ FROM VALUES OF THE TRANSFER CONSTANTS IN THE CASE OF THE RADIOCHEMICAL POLYMERIZATION OF ACRYLONITRILE IN SPINNING SOLVENTS. Murgulescu, I. G.; Vlaglu, I. (Institut de Chimie Physique, Bucharest). Rev. Roum. Chim., 14: 411-17 (Apr. 1969). (In Rumanian).

From the values of the transfer constants ($C_{tr,s}$) in the case of the radiochemical polymerization of acrylonitrile in dimethylformamide, dimethyl sulfoxide, and in ethylene carbonate, the constants $Q_{tr}-e_{tr}$ have been evaluated from the Fuhrman–Mesrobian equation giving the following values: 4.53×10^{-5}; 2.10×10^{-5}; 2.05×10^{-5} and +0.30; +0.71; and +0.55. The values of the transfer constants ($C_{tr,s}$) at 40 and at 50° (in the case of ethylene carbonate) for the solvents listed above are: 32.40×10^{-5}; 8.12×10^{-5}; and 5.11×10^{-5}. (tr-auth)

43353 KINETICS OF REACTION OF CO_2 WITH CARBON UNDER γ IRRADIATION. Zhitneva, G. P.; Pshezhetskii, S. Ya. At. Energ. (USSR), 26: 505-7(June 1969). (In Russian).

The kinetics of the reaction $CO_2 + C \rightarrow 2CO$ under γ radiation has been studied under the pressure 1 to 55 atm and intensity of radiation 290 to 1140 rad/sec. The temperature was 80 to 85°C. The reaction is of first order. The velocity of the reaction is proportionate to the intensity of radiation and the value of carbon surface. The dependence of reaction velocity from the CO_2 pressure, and the value of the carbon surface were in agreement with the derived equation for reaction velocity. (auth)

43354 EPR OF Ag^0 SITE CONVERSION IN GAMMA-IRRADIATED FROZEN $AgNO_3$ ICES. Bales, B. L.; Kevan, L. (Univ. of Kansas, Lawrence). Chem. Phys. Lett., 3: 484-7 (July 1969).

The gamma radiolysis of $AgNO_3$ ice at 77°K produced Ag^0 in 4 magnetically distinct sites due to different orientations of water dipoles. Site interconversion which occurs by rotation of water dipoles due to removal of the electric field of Ag^+ was studied by EPR. (auth)

43355 HIGHLY EFFICIENT MONOMERIZATION OF THYMINE DIMERS BY GAMMA IRRADIATION IN THE SOLID STATE. Snipes, Wallace; Deering, R. A. (Pennsylvania State Univ., University Park). J. Chem. Phys., 51: 1268-9(Aug. 1, 1969).

The production of thymine by γ irradiation of $(TT)_D$ (thymine dimers formed by uv irradiation of thymine in frozen aqueous solutions) in the solid state is reported. The yields observed for this process are unusually high, the average energy absorbed per thymine molecule produced being much less than the strength of the bonds that must be broken to monomerize the dimer. At low doses (<300 kR) the absorbance increases linearly with exposure, but at high doses a decrease in yield with increasing dose is observed. A G-value of 1040 for thymine production or 520 for $(TT)_D$ breakage was calculated from the slope of dose–response curves. After 60 MR, G values are 20 for thymine production and 10 (or greater) for $(TT)_D$ breakage. (D.H.M.)

43356 CALORIMETRIC DETECTION OF FREE RADICALS IN IRRADIATED POLYETHYLENE. Currie, James A.; Boehm, G. G. A.; Dole, Malcolm (Northwestern Univ., Evanston, Ill.). J. Polym. Sci., Part B, 7: 535-9(July 1969).

Qualitative calorimetric evidence is given for the exothermic heat of reaction due to recombination of allyl- and polyenyl-type free radicals in irradiated polyethylene. The yields of allyl-type free radical were calculated from the net exothermic heat of free radical recombination by assuming that the heat of the reaction was -34.2 kcal mole^{-1}. The equations used in the calculation of G(allyl-type free radicals) are given. Uncertainties in the experiment are discussed. (P.C.H.)

43357 IONENE POLYMERS. IV. ELECTRON SPIN RESONANCE OF Co γ IRRADIATED CATIONIC CROSSLINKING AGENTS. Rembaum, A. (California Inst. of Tech., Pasadena); Hermann, A. M. J. Polym. Sci., Part B, 7: 507-14(July 1969).

EPR spectral studies were made on the irradiation of three cationic crosslinking agents (methacrylate, acrylate, and an allyl crosslinking agent) in the solid state by means of a Co γ source. The relative stability of the crosslinked polymers became obvious during the study. Solvent extraction and liquid gas chromatography showed an absence of volatile products after a 140-Mrad dose. The ir spectrum of the irradiated polymer was identical to the ir spectrum of the polymer obtained by redox polymerization of the monomer. (P.C.H.)

43358 ESR STUDIES ON X-IRRADIATED SALTS OF LEUCINE. III. STRUCTURE OF RADICALS IN IRRADIATED SINGLE CRYSTALS OF L-LEUCINE.HBr AND L-LEUCINE.DBr. Lassmann, G.; Damerau, W. (Institut fuer Biophysik, Berlin). Biophysik, 6: 76-84(1969). (In German).

The structure of a hitherto unknown type of radical in L-leucine was investigated in x-irradiated single crystals of L-leucine · HBr and L-leucine · DBr. At room temperature a radical is formed and the correspondent averaged hyperfine coupling constants are: $a_{H\alpha}$ = 20.5 G; $a_{H\beta}$ = 19.0 G; and $a_{H\beta}$ = 26.5 G. Besides this type in irradiated L-leucine · HBr exist radicals of the type $(CH_3)_2 > \dot{C}H - CH_2-\overset{+}{C}HNH_3 \cdot COOH \cdot X$ (X = Br^-), which represent the major part of radicals (with X = Cl^-) in irradiated L-leucine · HCl. The separation of these comparatively short-lived species was not possible by usual annealing, but by different stability of the two types in different lattice-matrices of the leucine-salts L-leucine · HCl and L-leucine · HBr. (auth)

43359 ELECTRON SPIN RESONANCE OF FREE RADICALS IN X-IRRADIATED CHOLESTEROL AND 5,6-DIHYDRO-CHOLESTEROL. Hellinger, O. (Gesellschaft fuer Strahlenforschung, Nuremberg). Biophysik, 6: 63-8(1969). (In German).

A new interpretation of the electron spin resonance spectrum of x-irradiated pure cholesterol powder was established because in Gordy's former interpretation the difference between the hyperfine splittings of the ESR spectrum from axially and equatorially oriented H atoms in the cyclic part of the cholesterol molecule was neglected. The new interpretation (Cholesteryl-7) was found with regard of data from Onishi and Nitta measured on the cyclohexenyl radical, by identifying the triplet splitting (a = 26 Oe) in the ESR spectrum of irradiated cholesterol with both axial $H_{\beta 1}$ resp. $H'_{\beta 1}$ atoms and correlating the doublet splitting (a = 15 Oe) with the $H_{\alpha 2}$ atom and by accepting the hyperfine splittings of the $H_{\alpha 1}$ atom and of the equatorial $H_{\beta 2}$ atom not exceeding 6 Oe and therefore not being resolved because of the considerable line width of about 10 Oe. The unpaired electron's localization near the double bond was shown by a control experiment with 5,6-dihydrocholesterol. (auth)

43360 EFFECT OF POSITIVELY CHARGED IONS ON THE MOLECULAR HYDROGEN YIELD IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. Faraggi, M.; Desalos, J. (CEN de Saclay, Gif-sur-Yvette, France). Int. J. Radiat. Phys. Chem., 1: 335-44 (1969).

The radiolytic hydrogen yield G_{H_2} from deaerated aqueous solutions of metal ions was investigated. In Ni^{2+}, Co^{2+}, and Zn^{2+} solutions G_{H_2} was constant and no solute concentration effect was observed. In Cd^{2+}, Cu^{2+}, Pb^{2+}, and acidic Hg^{2+} solutions G_{H_2} decreased with increasing solute concentration and the order of the efficiency of the metal ions in reducing the hydrogen yield was $Cd^{2+} < Cu^{2+} < Pb^{2+} < Hg^{2+}$. The fact that all these metal ions are good scavengers for the reducing species led to the conclusion that e^-_{aq} or H atoms are not the main precursors of H_2. Homogeneous kinetics were used to express the dependence of G_{H_2} on solute concentration. The rate-determining step is considered to be the first-order disappearance of H^- produced by the reaction of subexcitation electrons with water as proposed by Platzman. The chemical reactivity of the above ions towards H^- was found to be governed by the rate of substitution of H^- on the aquated metal ion and the relative reactivity values found were in good agreement with Eigen's values for ligand substitution. It was also found that a small part (≈10 per cent) of the H_2 may be produced by the reaction of H atoms with the reduced form of the metal ion M^+. (auth) (UK)

43361 PULSE RADIOLYSIS AT HIGH PRESSURE: PRESSURE DEPENDENCE OF THE ABSORPTION SPECTRUM AND THE LIFETIME OF HYDRATED ELECTRONS. Schindewolf, U.; Kohrmann, H.; Lang, G. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Angew. Chem. Int. Ed. Engl., 8: 512-13(July 1969).

A successful method is described for measuring the pressure dependence of the absorption spectrum and the lifetime of hydrated electrons produced by radiolysis of aqueous solutions by high-energy electrons from a pulsed linear electron accelerator (up to 300 pulses of 5-μsec duration per sec; 15 MeV, 0.5 A). The results demonstrated that the rate of reaction, or the mean lifetime of the hydrated electrons, with regard to the reaction $2e^- + 2H_2O \rightarrow H_2 + 2OH^-$ (and with regard to the reaction with the unidentified impurity) is independent of pressure, i.e., that the activation volume of these reactions is vanishingly small. These direct measurements of the rate of reaction under pressure confirmed the results obtained by others by indirect methods. (P.C.H.)

43362 RADIATION-INDUCED OXIDATION OF BUTYRALDEHYDE IN HEPTANE SOLUTIONS. Saraeva, V. V.; Arshakuni,

A. A. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 39-43(May-June 1969). (In Russian).

Radioinduced oxidation of butyraldehyde in heptane was studied at 0°C at aldehyde concentrations ranging from 1.0×10^{-3} to 2.0×10^{-2} M. (auth)

43363 RADIATION CHEMISTRY OF AQUEOUS POTASSIUM PERMANGANATE SOLUTIONS. Upadhyay, S. R.; Debuyst, R.; Apers, D. J.; Capron, P. C. (Univ., Louvain). Radiat. Eff., 1: 151-60(July 1969).

The radiolysis of potassium permanganate solutions was studied by means of a double tracer technique and a new analytical procedure in parallel with an ESR investigation. In this way it has been possible to determine without doubt that the only radiolytic product formed is MnO_2 in neutral solutions and Mn(II) in acid solutions. In the latter case Mn(II), at least to a major part, appears to accumulate after the end of the irradiation. At the same time it disappears, oxidized by permanganate. Several suggestions are advanced to explain this radiolytic and post-irradiation behavior. (auth)

43364 CHARGE SCAVENGING IN NON-POLAR LIQUID STUDIES BY ELECTRICAL CONDUCTIVITY MEASUREMENT. Hayashi, Kanae; Takada, Kiyoshi; Hayashi, Koichiro; Okamura, Seizo (Japan Atomic Energy Research Inst., Osaka). Radiat. Eff., 1: 109-16(Apr. 1969).

Radioinduced electric conductivity in n-hexane has been measured as a function of the concentration of charge scavenger of low diffusion constant, such as 1,2-benzanthracene, 1,2-benzophenanthrene, pyrene, and naphthacene. With increasing scavenger concentration, a gradual decrease of relative electric conductivity, down to an individual value corresponding to each scavenger, has been observed. This is interpreted as implying that both negative and positive charge carriers, or free ions, are reactive entities throughout their lifetime. The charge scavenging efficiencies have been found to lie in the following order: 1,2-benzanthracene = 1,2-benzophenanthrene < pyrene < naphthacene. (auth)

43365 RADIOLYTIC REDUCTION OF URANYL ION. Hyder, M. L. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Radiat. Eff., 1: 191-5(July 1969).

Uranyl ion was reduced to U^{4+} by ionizing radiation in deoxygenated solutions containing organic solutes. The reduction was effected by free radical species formed from the organics and perhaps in part by H atoms from H_2O decomposition. A detailed study of uranyl oxalate solutions showed that the role of H_2O_2 in this system is complex and that chain-type reactions involving this species can occur. (auth)

43366 YADERNO-KHIMICHESKIE YAVLENIYA V TVERDYKH TELAKH. (Nuclear-Chemical Processes in Solids). Tbilisi, USSR, Izdatel'stvo Metsniereba, 1968. 120p.

Sixteen articles are included on the experimental studies of hot hydrogen atom reactions on the surface and inside solids and of radiation effects on the properties of solid materials. Radiation-accelerated diffusion of tritium into lithium chloride and reactions of hot atoms of tritium in a heterogeneous system in the presence of an acceptor are discussed in the first two articles. Electron microscopic studies of reactor-irradiated lithium fluoride crystals, radioinduced ethane transformation on silica gel, and the algorithms for treating radiochromatographic analysis are covered in the next three articles. The sixth, seventh, and eighth articles discuss the radiation adsorption of hydrogen atoms on aluminum surfaces and silicon oxide surfaces, the influence of ethane pressure on its reactions with tritium recoil atoms, and separation of tritium from LiH polycrystals irradiated in a nuclear reactor. The yield of tritium-labeled compounds with various ratios of adsorbed and non-adsorbed gas, radiative chemical sorption of ethane on the surface of silica gel, preparation of deuterated silica gel and determination of deuterized surface, and low-temperature microcalorimetric studies of irradiated LiF are covered in the next several articles. The last three articles deal with the radioinduced hydrogen exchange of ethane with silica gel hydroxide groups, chromatographic computer device for studying heterogeneous phase systems, monitoring fast neutron flux by threshold detectors, and automatic temperature control for special studies. (R.V.J.)

43367 THERMOLUMINESCENCE IN IRRADIATED ORGANIC POLYMERS. Fleming, R. J. (Monash Univ., Clayton Australia). Proc. Royal Austr. Chem. Inst., 36: 199-202(July 1969).

Thermoluminescence studies can yield useful information at the electronic level on the effects of radiation. A mechanism for thermoluminescence in a typical ionic crystal is illustrated; essentially the same sequence of events could apply to organic polymers. The origins of first and second order (mono- and bimolecular) kinetics are briefly outlined. Typical irradiation vessel and phase-sensitive detection techniques are illustrated. Glow-curves are given for polyethylene, poly(methyl methacrylate), and polystyrene. Extension of the work to a wide variety of samples may lead to a general statement on the involvement of impurities with thermoluminescence in polymers. (Australia)

43368 SYNTHESIS OF ACYCLIC ISOPRENOIDS BY THE γ-IRRADIATION OF ISOPRENE. Munday, C.; Pering, K.; Ponnamperuma, C. (Ames Research Center, Moffett, Field, Calif.). Nature (London), 223: 867-8(Aug. 23, 1969).

The presence of saturated "isoprenoid" hydrocarbons is often cited as evidence for the biogenic origin of organic compounds present in ancient sediments, and although there is much evidence in support of this view, the possibility of an abiogenic synthesis should not be overlooked. An investigation is described on whether branched chain acyclic polymers can be produced from isoprene under plausible geochemical conditions. Isoprene is a by-product in the thermal cracking of ethane and propane, which may in turn be produced by the action of uv radiation or electrical discharges on methane, a constituent of the primordial atmosphere, and it seems likely that some isoprene may have been formed on the prebiotic earth. Of the primordial sources of energy, ionizing radiation is able to cause polymerization. Two series of experiments were made; in the first, isoprene was irradiated with ^{60}Co γ-rays in sealed tubes, while in the second isoprene was adsorbed on vermiculite before irradiation. Vermiculite possesses catalytic activity and simulates a geological surface on which isoprene could be adsorbed without alteration by the action of uv light. The total absorbed γ-dose was $\sim 2 \times 10^7$ R. The γ-irradiation of isoprene in sealed tubes produced a mixture of cyclic unsaturated polymers, as shown by gas chromatography and mass spectrometry. Irradiation of the adsorbed isoprene, however, yielded largely a series of open chain compounds. Hydrogenation to form saturated compounds is compatible with geological processes, since free hydrogen is invariably produced in the irradiation of hydrocarbons. The results indicated that a plausible abiogenic synthesis was accomplished. The possibility cannot be ruled out, however, that isoprenoids formed in ancient sedimentary rocks, or extraterrestrial samples, could have been formed by a combination of biogenic and abiogenic processes. (UK)

43369 ISOLATION OF CARRIER-FREE ^{88}Y FROM STRONTIUM TARGETS. Levin, V. I.; Kurchatova, L. N.; Malinin, A. B. Radiokhimiya, 11: 210-14(1969). (In Russian).

The absorption of carrier-free ^{88}Y from hydrochloric acid solutions on columns filled with granulated fluoroplastic material covered by a film of bis(2-ethylhexyl) phosphate was studied. This method was used for separation of ^{88}Y from irradiated strontium cyclotron targets. The yield of ^{88}Y was above 90%. The coefficient of purification of ^{88}Y from strontium was approximately 5×10^4 Radioactive impurities did not exceed 0.01%. (tr-auth)

43370 INITIAL DAMAGE CENTER IN γ-IRRADIATED α-AMINOISOBUTYRIC ACID. Cadena, David G. Jr.; Linder, Robert E.; Rowlands, John R. (Southwest Research Inst., San Antonio). Can. J. Chem., 47: 3429-34(Sept. 15, 1969).

Electron spin resonance measurements of single crystals of α-aminoisobutyric acid, which are both irradiated and measured at 77°K, give rise to a strong central absorption line at the center of two weak "satellite" peaks. The species largely responsible for the intensity of the central absorption line was discussed previously and is considered to be the doubly ionized radical anion. Evidence is presented which shows that some of the intensity of this central line is contributed by the species giving rise to the satellite lines. Furthermore, this evidence, which is based upon saturation studies, variable temperature measurements, deuteration studies, and complete neglect of differential overlap-self consistent field molecular orbital calculations, suggests that the species giving rise to the satellite spectra is a planar conformation of the radical $(CH_3)_2CCO_2H$. (auth) (Canada)

43371 RADIATSIONNAYA MODIFIKATSIYA POLIMERNYKH MATERIALOV. (Radiation Modification of Polymers). P'yankov, G. N.; Meleshevich, A. P.; Yarmilko, E. G.; Kabakchi, A. M.; Omel'chenko, S. I. Kiev, Tekhnika, 1969. 232p.

Radiation modification of polymers, intermolecular bonds in polyethylene, and use of oligodimensional systems as binders for plastics are reviewed. Radiation technology of polyethylenes, radiation effects on structure of unsaturated polyesters, and regularities of radiation-chemical transformations of epoxy compounds are discussed. Radiation sources, ionizing radiation dosimetry, and economic aspects of the radiation technology of polymers are also considered. (439 references). (R.V.J.)

43372 SLOW ELECTRON IRRADIATION EFFECT ON COENZYME NADH. Saito, Masahiro; Yoshii, Giichi (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 2: 30-5(1969).

Thin layers of coenzyme NADH, indexed as nicotinamide-adenine dinucleotide, were irradiated with very slow electrons in an energy range of 6 to 40 eV. UV absorption spectra of the samples were determined before and after the irradiation. The absorbance at 340 mμ was found to decrease with the increment of that at 260 mμ. This observation was interpreted as an evidence that a rearrangement of the electronic configuration takes place in the pyridine ring of a NADH molecule attacked by slow electrons. The decrease of the absorbance at 340 mμ depends upon the incident electron energy characteristically when the total electron dose is much less than the number of the target molecules. It increases with an increasing electron energy more than 30 eV and decreases below 15 eV, being maximum near 22 eV possibly due to the plasma excitation of the valence electrons. (auth)

43373 ELECTRON SPIN RESONANCE SPECTRA OF IRRADIATED ORGANIC GLASSES. Shiga, Tetsuo; Yoshida, Hiroshi; Higashimura, Takenobu; Okamura, Seizo (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 2: 80-2(1969).

ESR spectral studies on γ-irradiated 3-methylhexane and tetrahydro-2-methylfuran glasses indicated the presence of cationic intermediates in the irradiated glasses. (J.G.B.)

43374 DECAY OF ELECTRONS TRAPPED IN IRRADIATED 3-METHYLHEXANE GLASS STUDIED BY ELECTRON SPIN RESONANCE. Yoshida, Hiroshi; Irie, Masahiro; Warashina, Tetsuo; Higashimura, Takenobu (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 2: 78-9(1969).

In order to study the nature of the trapped electrons in nonpolar organic glasses, ESR experiments were carried out on the trapped electrons in γ-irradiated 3-methylhexane glass, at 77°K. The irradiated samples gave an ESR signal composed of a sextet spectrum due to free radicals formed from 3-methylhexane molecules and a sharp singlet spectrum due to the trapped electrons. Trapped electrons were of two types, those that disappeared quickly and those that disappeared slowly. (J.G.B.)

43375 HOT ATOM CHEMISTRY OF PHENYLSULFUR COMPOUNDS. Kawamoto, Keizo; Kobayashi, Mitsue; Kitaoka, Yoshinori; Takada, Jitsuya; Kiso, Yoshiyuki (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 2: 7-12(1969).

The chemical reaction of recoil ^{32}P produced by the $^{32}S(n,p)^{32}P$ reaction of phenylsulfur compounds was investigated. The target materials containing many oxygen atoms in their molecule have a tendency to yield the higher percentage of the products soluble in aqueous solution. The recoil products were separated into components by paperchromatography. The number of separated products and their distribution are greatly influenced by the chemical forms of target materials. The effects of benzene dilution on the distribution patterns of the recoil products were also investigated. (auth)

43376 DETERMINATION OF WATER-SOLUBLE PRODUCTS OF THE RADIOLYSIS OF PHOSPHATE CATION EXCHANGERS. Kott, V. N.; Kuzin, I. A.; Semuchin, A. M. Zh. Prikl. Khim., 42: 1332-5(June 1969). (In Russian).

A paper chromatographic method was developed for separation of products from the gamma radiolysis of phosphate cation exchangers. The main product was found to be PO_4^{3-}. (M.C.G.)

Radiochemistry

43377 DETERMINATION OF THE ABSOLUTE ACTIVITY OF ^{125}I. Erbeszkorn, Lajos; Szokolyi, Laszlo; Szoerenyi, Arpad; Zsdanszky, Kalman. Atomtech. Tajek., 11: 358-63(July 1968). (In Hungarian).

The absolute activity of the ^{125}I isotope was determined by an integral coincidence method with an error of ±2%. The samples were prepared by two methods: plane solid sources were measured by thin cylindrical scintillators, and liquid sources in ampoules by well-type ones. In the case of plane solid sources, the iodine was stabilized in the form of AgI. The results achieved by these methods were found to be in good agreement. The results of comparative activity measurements organized by the Institute of Isotopes of the Hungarian Academy of Sciences are also presented. (auth)

Separation Processes

Refer also to abstracts 43254, 43291, 43325, 43347, 43399, 43492, 43501, 43502, 45046, 45047, 45096, and 45109.

43378 (ANL-7503) RETORTING UNIT FOR RECOVERY OF URANIUM FROM ZINC-MAGNESIUM SOLUTIONS. Lenc, J. F.; Miller, W. E.; Bernstein, G. J.; Chandler, A. L.; Paul, R. C.; Johnston, E. F. (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 32p. Dep. CFSTI.

A remotely operable retorting unit was developed for recovering up to 5 kg of uranium metal from zinc-magnesium solvent solutions. The unit separates the uranium from the more volatile Zn-Mg solution by vacuum distillation and consolidates the retorted uranium product by melting it into a form suitable for remote handling. Reliable operation was established during 45 runs conducted at a nominal pressure of 10 torr with charges bearing unirradiated uranium. The bulk of the Zn-Mg solutions distilled between 650 and 750°C. The remaining volatile material was vaporized and the uranium product was melted by increasing the temperature to between 1200 and 1250°C for about one hour. The uranium product was recovered in the form of a consolidated ingot. The purity of the uranium product was considered to be acceptable for recycled reactor fuel. Six different thixotropically cast beryllia crucibles were tested. They remained intact and satisfactorily contained the nominal Zn-12 wt % Mg-12 wt % U retorting solutions. A small amount of the solution seeped through the crucible wall during each run. As a result, a small quantity (less than 25 g) of the uranium product was found in the annular space between the crucible and its graphite secondary container after each run. The seepage was not considered to be significant because the uranium found in the annulus could be recovered by pyrochemical processing if necessary. A minimum useful life of ten retorting runs was demonstrated for thixotropically cast beryllia crucibles. (auth)

43379 (ARH-1279) RECOVERY OF RHODIUM, PALLADIUM, AND TECHNETIUM ON STRONGLY BASIC ANION EXCHANGE RESIN. Panesko, J. V. (Atlantic Richfield Hanford Co., Richland, Wash.). July 1969. Contract AT(45-1)-2130. 21p. Dep. CFSTI.

Selective ion exchange recovery of palladium, rhodium, and technetium from nuclear reprocessing wastes was demonstrated by use of two resin columns in series. Partial separation of palladium from rhodium and technetium was obtained in the loading step of the first column where a cumulative 90% Pd, 37% Rh, and 23% Tc were recovered from 900 bed volumes. Ninety % of the remaining Rh, Tc, and Pd was recovered on the second column when less than 300 bed volumes of Column 1 effluent were used per loading cycle. Rhodium and technetium were selectively eluted with HNO_3; and, subsequently, palladium was eluted with NH_4OH. Uneluted Rh, Pd, and Tc were simultaneously removed with NH_4SCN. (auth)

43380 (BNL-50130) DEVELOPMENT OF THE PHOSPHATE GLASS PROCESS FOR ULTIMATE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES. Drager, R. F.; Emma, L. C.; Fedelem, J. J.; Hatch, L. P.; Strickland, Gerald; Tuthill, E. J.; Weth, G. G. (Brookhaven National Lab., Upton, N. Y.). Jan. 1968. 50p. Dep. CFSTI.

Incorporation, or fixation, of fission products in stable solid media, followed by storage of the solid in geologically stable regions, offers a highly promising approach to the problem of ultimate disposal of high-level radioactive wastes. The phosphate glass process, is discussed in detail. It is carried out in an all-liquid system, under steady-state conditions, and offers the inherent advantages of the continuous mode of plant operation. Development of the process was carried through the pilot plant stage with simulated waste solutions at Brookhaven National Laboratory, and is now being demonstrated on a more comprehensive scale with high-level radioactive waste solutions in a prototype plant at Pacific Northwest Laboratory. (auth)

43381 (DOCKET-50332-5) BARNWELL NUCLEAR FUEL PLANT. Safety Analysis Report, Amendment 3. (Allied Chemical Nuclear Products, Inc., Florham Park, N. J.). Aug. 15, 1969. 454p. Dep. CFSTI.

Revisions to the safety analysis report are included. Topics covered include: general considerations, confinement, ventilation and off-gas systems, process systems, criticality control and nuclear safety, site studies, consultants' reports, design bases, effluents, and final soils investigation. (M.C.G.)

43382 (IS-T-293) SULFOXIDES AS SOLVENT EXTRACTION REAGENTS FOR THE ANALYTICAL SEPARATION OF METAL IONS. Kennedy, David Colin (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 156p. Dep. CFSTI. Thesis.

The sulfoxides, a new class of solvent extraction reagents, were evaluated for use in the separation of metal ions. The compounds most extensively studied were di-n-octyl sulfoxide, p-tolyl sulfoxide, and two previously unreported bifunctional sulfoxides;

bis(n-octylsulfinyl) methane and bis(n-octylsulfinyl)ethane. Using the rapid, qualitative technique of reversed-phase paper chromatography, the interactions of these sulfoxides with some 50 metal ions were investigated in several acid–ligand systems. All four reagents were studied in 1 to 10 M hydrochloric acid and 1 to 11 M nitric acid. Di-n-octyl sulfoxide and bis(n-octylsulfinyl)methane were also studied in perchloric acid and in ammonium thiocyanate–perchloric acid mixtures. From the results, several analytical separation systems were devised. To demonstrate the utility of these systems, a number of metal combinations were quantitatively separated by batch extraction or by reversed-phase column chromatography. The results showed evidence of four distinct mechanisms of extraction for monofunctional sulfoxides. It was observed that, as predicted, the bis sulfoxides were apparently able to exhibit bidentate coordination in the extraction of certain metals. Thorium(IV), titanium(IV), zirconium(IV) and hafnium(IV), were quantitatively separated by reversed-phase column chromatography. An analytical system was studied in detail which permits the separation of uranium(VI) from over 50 metal ions with palladium(II), gold(III) and mercury(II) being the only possible interferences. (81 references). (P.C.H.)

43383 (JUL-565-CT) ON THE THERMOCHEMISTRY OF THE MATERIAL SYSTEMS U, Th, Pa, C, O_2, Cl_2. Krahe, Josef; Mueller, Franz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Dec. 1968. 39p. (In German). Dep. CFSTI (U. S. Sales Only).

Thermochemical principles for the chloride volatility process are considered. Chlorination of ThO_2, UO_2, and Pa in the presence and absence of carbon by chlorine gas was studied. Data are presented in tables and graphs. (M.C.G.)

43384 (KFK-691) THE INFLUENCE OF THE RADIOLYSIS OF TRIBUTYLPHOSPHATE ON THE PLUTONIUM YIELD IN THE PUREX PROCESS AT HIGH PLUTONIUM CONTENT. Stieglitz, L.; Ochsenfeld, W.; Schmieder, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Nov. 1968. 31p. (In German). (EUR-3712). Dep. CFSTI (U. S. Sales Only).

The formation of dibutyl phosphate under the action of α, β, and γ radiation on the system TBP–C_nH_{2n+2}–HNO_3–H_2O was studied. The presence of an aqueous phase and oxygen appears to have a strong influence on the radiolytic decomposition of TBP. The influence of the radiolysis of TBP on plutonium extraction in the Purex Process was investigated. The plutonium back-extraction after the 4th or 5th back-wash was proportional to the radiation dose and directly dependent on the dibutyl phosphate concentration. (M.C.G.)

43385 (ORNL-4429) STATUS AND PROGRESS REPORT FOR THORIUM FUEL CYCLE DEVELOPMENT FOR 1967 AND 1968. Wymer, R. G.; Lotts, A. L. (comps); Peterson, Sigfred (ed.) (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 169p. Dep. CFSTI.

Progress is reported under the following topics: process demonstration and ^{233}U distribution, thorium–uranium recycle facility, sol-gel process development, fueled-graphite fabrication development, irradiation of coated-particle fuels, bulk oxide process development, characterization of oxide fuels, irradiation of bulk oxide fuels, and advanced studies. (M.C.G.)

43386 FRANCE: PARTNER IN ALL AREAS OF THE FUEL CYCLE. Mabile, J. (CEA, Paris). Atomwirt., Atomtech., 14: 291-3(June 1969). (In German).

Uranium deposits, reprocessing, and ^{235}U enrichment in natural uranium are discussed. French investigations in these areas are considered. (M.C.G.)

43387 ADSORPTION OF URANIUM BY ION EXCHANGE RESINS IN THE PRESENCE OF CHLORATE AND OF PERCHLORATE. Tataru, S.; Filip, Gh.; David, B. (Section de Recherches Technologiques pour les Metaux Rares, Bucharest). Rev. Roum. Chim., 14: 599-604(May 1969). (In Rumanian).

The study of the adsorption of uranium by ion exchange resins from carbonate solutions in the presence of chlorate and perchlorate ions showed that these ions have a negative influence on the process by reducing the adsorption capacity of the resin for uranium. The chlorate and perchlorate ions are adsorbed by the ion exchange resin in preference to the uranium, the perchlorate ion eluting the uranium adsorbed in the previous stages. (tr-auth)

43388 INCORPORATION OF RADIOACTIVE WASTES INTO BITUMEN. Kolychev, B. S.; Kulichenko, V. V.; Khonikevich, A. A.; Sedov, V. M. At. Energ. (USSR), 26: 530-6(June 1969). (In Russian).

A survey was made on research on incorporation of radioactive wastes into bitumen. New trends and developments in this field were also analyzed. Comparative advantages as well as limitations of this method are discussed. (auth)

43389 EXTRACTION OF BERYLLIUM FROM THIOCYANATE SOLUTIONS BY ORGANIC SOLVENTS IN THE PRESENCE OF AMINES. Novoselova, A. V.; Pochkaeva, T. I.; Tamm, N. S.; Trubacheva, G. A. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 44-8(May-June 1969). (In Russian).

The extraction of beryllium from thiocyanate solutions by organic solvents was found to increase noticeably in the presence of amines. Data are given on the effects of primary, secondary, and tertiary amines on such organic solvents as alcohols, esters, ketones, and non-polar solvents. (P.C.H.)

43390 PURIFICATION OF CESIUM AND RUBIDIUM METALS BY CHLORIDE REDUCTION UNDER HIGH VACUUM CONDITIONS. Schmidt, P. H. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 116: 1279-82(Sept. 1969).

High-purity Cs and Rb metal has been obtained for the first time for electronic structure studies. High-purity results were obtained by the reduction of a purified chloride using Ca metal. Apparatus design, low operating temperature (<400°C), high-purity salts, improved collection practices, and high vacuum operation were essential for successful results. Electrical resistivity ratios of purified Cs and Rb metals are $R_{300°K}/R_{1.5°K}$ 4400 and 3500, respectively. (auth)

43391 STUDY OF SEPARATION OF URANIUM FROM IMPURITIES BY CHROMATOGRAPHY ON PAPER IMPREGNATED WITH AMMONIUM SILICOTUNGSTATE. Marcu, Gheorghe; Ghizdavu, Letitia. Stud. Univ. Babes-Bolyai, Ser. Chem., 14: 39-42(1969). (In Rumanian).

Optimum conditions were determined for the separation of uranium from ^{134}Cs, ^{90}Sr, ^{90}Y, ^{60}Co, ^{65}Zn, ^{152}Eu, ^{140}La, ^{141}Ce, and $^{55+59}Fe$, as well as from Ni, Cu, and Bi. Chromatographic paper impregnated with ammonium silicotungstate was used. Elution was performed with 0.01 to 1M $HClO_4$. The dependence between impregnation density and duration of migration was studied. The method can be applied to the analysis of the fission products of uranium and to the determination of uranium in minerals. (auth)

43392 SEPARATION OF RADIUM AND BARIUM BASED ON THE MOBILITIES OF THE IONS. Kiselev, B. P. Radiokhimiya, 11: 252-4(1969). (In Russian).

Experiments on the separation of sodium from barium in a column in countercurrent flow show that radium and barium can be separated by the method of ionic mobility since the mobility of the sodium ion is very similar to the mobility of the radium ion. (M.C.G.)

43393 EXTRACTION OF TECHNETIUM AND RHENIUM WITH 8-MERCAPTOQUINOLINE. Kuznetsov, V. I.; Gudym, L. S.; Rudenko, N. P.; Khadi Kadom Avad. Radiokhimiya, 11: 240-2(1969). (In Russian).

The extraction of trace amounts of technetium and rhenium by chloroform solutions of 8-quinolinol, 2-methyl-8-quinolinol, 5,7-dibromo-8-quinolinol, and 8-mercaptoquinoline was studied. The elements were extracted in both the tetravalent and heptavalent states. (M.C.G.)

43394 THE MECHANISM OF EXTRACTION OF URANIUM(VI) BY MONOBASIC ORGANIC PHOSPHORUS ACIDS FROM NITRATE SOLUTIONS. Vdovenko, V. M.; Vavilov, N. G. Radiokhimiya, 11: 232-6(1969). (In Russian).

It is possible to explain the increase in the coefficient of distribution of uranium, in the nitric acid concentration range from 3 to 7M, by the formation, in the organic phase, of a complex of the type $[UO_2(NO_3)(HA_2)]_2 \cdot 2HA$. Conditions of formation of this complex are the extraction of uranium by two mechanisms: chelate formation and solvation. (tr-auth)

43395 THE SEPARATION OF POTASSIUM, CALCIUM, AND SCANDIUM BY COPRECIPITATION WITH IRON HYDROXIDE. Novikov, A. I.; Ruzankin, V. I.; Dolzhenko, Yu. K.; Starovoit, I. A. Radiokhimiya, 11: 227-9(1969). (In Russian).

In order to develop a method for separation of potassium, calcium, and scandium by coprecipitation with iron hydroxide, the effects of pH and other conditions were studied. The coprecipitation of small amounts of scandium in a 1M solution of ammonium nitrate was studied in the pH range from 2 to 11. The coprecipitation of small amounts of calcium from 1M solutions of ammonium chloride was studied under the same conditions. Precipitation of potassium with iron hydroxide did not occur in the pH range studied. In a proposed separation method, scandium is isolated at pH = 6.2 to 8.2 and calcium at pH > 9.5. (M.C.G.)

43396 OBTAINING HIGHLY PURE CERIUM OXIDE BY THE EXTRACTIONS METHOD. Mikhailichenko, A. I.; Pimenova, R. M.; Kotlyarov, R. V. Zh. Prikl. Khim., 42: 1262-5(June 1969). (In Russian).

The optimum conditions were found for extraction of cerium from mixtures of lanthanides and its subsequent purification using bis(2-ethylhexyl) orthophosphate. (M.C.G.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 43258, 43423, 43426, 43427, 43613, and 44782.

43397 (CONF-680309) PROCEEDINGS OF THE CONFERENCE ON HYDROLOGY IN WATER RESOURCES MANAGEMENT HELD IN CLEMSON, SOUTH CAROLINA, MARCH 28–29, 1968. Report No. 4. (Clemson Univ., S. C. Water Resources Research Inst.). Mar. 1968. 199p.

Twelve papers are included; a separate abstract was prepared for one. One paper on tracing soil moisture and groundwater flow at the Savannah River Plant was previously abstracted in NSA as 22: 21181. The remaining 10 papers contain information on: hydrologic systems for water resources management; Santee River basin survey; hydrology of wetland forest watersheds; experimental watersheds in TVA; watershed research in the Southeast; role of streamflow prediction in water resources management; flood frequency and water management; influence of rainfall interception on streamflow; water quality standards; and the Keowee–Toxaway Project. (L.C.L.)

For an abstract of the individual paper see: 43398.

43398 (CONF-680309, pp 153-67) THERMAL POLLUTION. Carter, R. S. Jr. (Savannah River Operations Office (AEC), Aiken, S. C.).

Thermal pollution, defined as the disadvantageous thermal effects of using natural water for industrial cooling, is examined in terms of its effects on ecology systems, particularly fish, and in light of future demands for coolant water for conventional and nuclear power plants. Recommendations are made for recognizing the benefits available due to small temperature changes and for controlling the disadvantages of large temperature changes by defining limits of permissible thermal changes, careful siting and design of new power plants, and further research into the complexities of thermal pollution. (L.C.L.)

43399 (DOCKET-50201–16) BURIAL OF LEACHED HULLS AT THE WEST VALLEY PLANT. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Sept. 2, 1969. 32p. Dep. CFSTI.

The standard procedure for transfer of radioactive process waste to burial in a site licensed by the USAEC at the West Valley Processing Plant is described. The soil in this leached hull burial area features a thick (>55 ft) layer of silty till with 4 to 6 ft of granular, glacial till overburden. The transport system chosen was a carrier that can be loaded and unloaded remotely with access batches in the top. Photographs of the site and operation are included. (M.C.G.)

43400 (PNE–322) PRESHOT GEOLOGIC AND ENGINEERING PROPERTIES INVESTIGATIONS. Lutton, R. J.; Hunt, R. W.; Rowland, R. E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Apr. 1969. 103p. Dep. CFSTI.

The site for the Buggy row charge cratering event is located on Chukar Mesa, NTS, in dry basalt. Topography is relatively flat over an approximately square area about 3,000 feet across. The site consists of about 330 feet of horizontal basalt flows resting on tuff breccia, other basalt flows, and a thick vitrophyric flow. Unconfined compressive strengths tend to decrease with increasing porosity from 33,000 psi for dense basalt to 6,200 psi for vesicular basalt with 20 to 30 percent vesicles. Tensile splitting and unconfined and triaxial compression tests on dense basalt indicate a failure envelope with ϕ of 50 degrees at normal stresses of 0 to 5,000 psi and ϕ of 30 degrees at normal stresses of 15,000 to 20,000 psi. Cohesion is about 5,000 psi. The Poisson's ratio for basalt ranges from 0.17 to 0.30 and is apparently not related to vesicularity. The weighted lineal joint intercept spacing for near-surface basalt averages about 0.3 foot and that at depth averages about 0.9 foot. Interlayered clinker zones apparently reduce the average seismic velocity of the medium by more than 50 percent. (auth)

43401 (TID–25134) ANALYSIS OF RADIONUCLIDE TRANSPORT PROJECT. Progress Report. (Texas Univ., Austin). [1969]. Contract AT(11-1)-490. 25p. Dep. CFSTI.

Prediction models for the transport of radionuclides into surface water have been investigated through the use of a model river system which simulated river processes in a flowing ecosystem. This study was undertaken to evaluate the environmental factors affecting radionuclide transport through laboratory ecosystems and a model river. Measurements of the amounts of radioactive tracers retained in water, plants, and sediments in the research flume were recorded. The results indicate that radioisotope transport in streams is influenced by the stream dispersion characteristics; the organic, inorganic, and thermal stream pollution; the amount of radioactivity already in the bed sediments; the amount of sediment agitation; and environmental factors such as plant growth, pH, light intensity, and oxygen content. Further experimental work for refining the mathematical models is recommended. (L.C.L.)

43402 (USGS–474-2) LITHOLOGIC LOGS ON SIX EXPLORATORY HOLES (UCe-9, -10, -11, -12a, -13, AND -14) DRILLED IN ALLUVIUM IN CENTRAL NEVADA. Corchary, G. S. (Geological Survey, Denver, Colo.). Dec. 1967. 19p. Dep. CFSTI.

Six exploratory holes were drilled in the central Nevada area to determine thickness and type of alluvium, and depth and type of bedrock. These holes, drilled during the period December 1966 through April 1967, were located in Antelope Valley, Little Smoky Valley, Hot Creek Valley, and Little Fish Lake Valley. Holes UCe-11 and UCe-12a were drilled to approximately 1,000 and 2,000 feet, respectively, below the alluvium/bedrock contact during the initial drilling; UCe-9 and UCe-10 were deepened after initial drilling failed to reach bedrock; the other two, UCe-13 and UCe-14, were bottomed as scheduled approximately 250 feet below the alluvium/bedrock contact. Depths to bedrock ranged from about 1,200 to 1,400 feet, in Antelope Valley (UC2-13) and Little Smoky Valley (UCe-14), respectively, to more than 3,000 feet in Hot Creek Valley (UCe-11). In Little Fish Lake Valley, more than 2,600 feet of lake and flood-plain deposited sands, silts, and clays overlie Paleozoic rocks in the southern part (UCe-10); similar but generally coarser alluvium, about 2,800 feet thick, overlies tuffaceous rocks in the central part (UCe-9); and less than 1,600 feet of coarse fan alluvium overlie welded tuffs in the northern part (UCe-12a). The alluvium and bedrock of Hot Creek Valley, at UCe-11, was judged most promising for further exploration on the basis of thickness, physical and drilling properties, and areal extent. (auth)

43403 (USGS–474–29) SUMMARY GEOLOGIC REPORT ON THE Ue13a DRILL HOLE, EASTERN BELTED RANGE, NYE COUNTY, NEVADA. Special Studies-78. Kargent, K. A. (Geological Survey, Denver, Colo.). June 1969. Contract AT(29–2)-474. 6p. Dep. CFSTI.

Drill hole Ue13a, located on the eastern side of the Belted Range, north of Oak Spring Butte, was completed in volcanic rocks at a total depth of 741 feet. The static water level is 425.5 feet below the surface. The lithologic and stratigraphic units penetrated in Ue13a are illustrated. (auth)

43404 (USGS–474–33) SOME PHYSICAL PROPERTIES OF ROCKS IN DRILL HOLE UAe-6c, AMCHITKA ISLAND, ALASKA. Amchitka 11-1. Lee, William H. (Geological Survey, Denver, Colo.). June 1969. Contract AT(29-2)-474. 14p. Dep. CFSTI. Includes Chart.

Physical properties of rocks from drill hole UAe-6c were analyzed by averaging and minimum-maximum ranging of data derived from Birdwell 3-D log computations. These physical properties and U. S. Geological Survey laboratory determinations of physical properties are presented in table form. Rocks in the drill hole were divided into 13 lithologic types for purposes of analysis. The physical property data of similar lithologic types were compared. The physical property trends indicate that age and depth of burial have some influence on the individual physical properties. (auth)

43405 ^{18}O ANALYSIS OF TAP WATER. Pillai, N. V.; Sharma, T. (Indian Inst. of Tech., Kanpur). Curr. Sci. (India), 38: 412-13(Sept. 5, 1969).

The ^{18}O content of tap water was measured using the CO_2 equilibrium method. The values are reported relative to standard mean ocean water. (M.C.G.)

43406 SOSTOYANIE I PERSPEKTIVY YADERNO-GEOFIZICHESKIKH METODOV POISKOV I RAZVEDKI POLEZNYKH ISKOPAEMYKH. VYPUSK 5. (Aspects and Perspectives of Nuclear–Geophysical Methods for Exploration and Prospecting of Natural Resources. 5th Edition). Alekseev, F. A. (ed.). Moscow, Izdatel'stvo Nedra, 1969. 344p.

Seventeen articles are included on the aspects of nuclear methods for geophysical exploration for oil and gas. Quantitative determination of neutron diffusion parameters by pulse neutron method, radioactive probing for super-depth holes, capture γ-radiation for evaluating the content of iron, zinc, and chromium, and photonuclear method for the composition of rocks and ores are discussed. Multichannel γ spectro-nuclear γ-resonance, and nuclear magnetic

resonance for studying the elementary composition rocks are also described. (R.V.J.)

43407 PROPERTIES OF SALT IMPORTANT IN RADIOACTIVE WASTE DISPOSAL. Bradshaw, R. L.; Empson, F. M.; Boegly, W. J. Jr.; Kubota, H.; Parker, F. L.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). Geol. Soc. Amer., Spec. Pap., No. 88, 643-59(1968).

From International Conference on Saline Deposits, Houston, Tex. See CONF-621104.

Tests have been conducted relating to ultimate disposal of highly radioactive power reactor wastes in salt mines. A number of laboratory and field tests have been conducted on properties of salt which are important in the design and operation of a waste-disposal facility. In situ heat transfer properties are sufficiently close to the values determined in the laboratory that confidence can be placed in theoretical heat-transfer calculations. Most bedded salt contains trapped moisture which is released with violence at temperatures above about 250°C. Radiation exposure doses of 5×10^8 roentgens produce some changes in structural properties, but the effect on mine stability should be negligible. Rock salt is approximately equivalent to concrete as a gamma-radiation shield. Stability of a waste-disposal mine at ambient temperature can be predicted from observed conditions in existing salt mines. Elevated temperatures will cause accelerated creep, but the exact effects on structural stability cannot yet be predicted accurately. (auth)

43408 NEVADA TEST SITE. Technical Sessions of the 18th Annual Meeting of the Rocky Mountain Section, Geological Society of America, held in Las Vegas, Nevada, May 11-14, 1966. Eckel, Edwin B. (ed.). The Geological Society of America, Inc., Memoir 110. Boulder, Colo., The Geological Society of America, Inc., 1968. 298p. $8.50. (CONF-660580).

Twenty-seven papers on the geology and hydrology of the Nevada Test Site are presented. The topics include information on: development of geologic knowledge at Nevada Test Site; geologic setting of Nevada Test Site and Nellis Air Force Range; application of geology to underground nuclear testing; applications of in-hole geophysical logs in volcanic rock; application of gravity data to geologic problems at Nevada Test Site; estimating distances to hydrologic boundaries from discharging well data; transport of dissolved chemical contaminants in ground water systems; stability index for underground structures in granitic rock; fault displacement as a result of underground nuclear explosions; regional thrust-fault system in Nevada Test Site and vicinity; some aspects of ground-water solution chemistry; and geology and hydrology of rocks and other materials in specific locations on the Nevada Test Site. (L.C.L.)

43409 SALINE DEPOSITS. A Symposium Based on Papers from the International Conference Held at Houston, Texas, 1962. Mattox, Richard B. (ed.). Geol. Soc. Amer., Spec. Pap., No. 88, 1-701(1968). (CONF-621104).

Twenty-nine papers are included. A separate abstract was prepared for 2. The remaining 27 papers include discussions on: 3 field areas in the U. S. underlain by extensive salt deposits; stratigraphy and structural geology; and geochemical and physical properties of saline deposits. Abstracts of 22 papers are also included. (J.C.W.)

For abstracts of individual papers see: 43407 and 43410.

43410 STRATIGRAPHY AND STRUCTURE OF THE TATUM SALT DOME AREA, SOUTHEASTERN MISSISSIPPI AND NORTHEASTERN WASHINGTON PARISH, LOUISIANA. Eargle, D. Hoye (Geological Survey, Austin, Tex.). Geol. Soc. Amer., Spec. Pap., No. 88, 381-405(1968).

From International Conference on Saline Deposits, Houston, Tex. See CONF-621104.

In the 3000-square-mile area of southeastern Mississippi and northeastern Washington Parish, Louisiana, which has Tatum dome in its center, rocks of known Jurassic to recent age are more than 20,000 feet thick. They are underlain by an unknown thickness of Louann Salt of Jurassic age. The age, thickness, and nature of the sedimentary rocks between the salt and the basement, as well as the character of the basement, are unknown. The salt in the northern half of the area has moved upward to shallow depths as diapirs in overlying rocks. Outside of the area of shallow-piercement domes there are more deeply seated domes, ridges, and anticlines that may be the result of vertical movement of the salt. The Wiggins anticline in the south and, southwest of it, an area dipping more steeply to the southwest probably were not affected by salt movement. Structural maps of four horizons and isopach maps of rocks in the three intervals between them give information about the sedimentary and structural history of the region since the end of Early Cretaceous time. The horizons contoured mark either unconformities or the upper boundaries of zones of fairly uniform structural history. The top of the Lower Cretaceous rocks dips generally to the west. Upper Cretaceous rocks dip to the west-southwest and thicken to the northeast. Pre-Miocene Tertiary rocks dip to the southwest and thicken to the northwest. Miocene and later rocks dip and thicken to the south-southwest. The structure of the older formations is considerably more irregular than that of the younger ones; domes, ridges, and basins were conspicuous in the Early Creataceous became less pronounced as younger sediments progressively covered them. Of eight known shallow-piercement domes, three have penetrated Oligocene rocks; two, middle Eocene; one, lower Eocene; one, Upper Creataceous; and one, Lower Cretaceous. Some movement has taken place at Tatum dome since the sandy, gravelly Citronelle Formation was laid down. (auth)

43411 RETENTION OF SELECTED RADIONUCLIDES FROM DILUTE SOLUTIONS BY PANAMANIAN CLAYS. Goldsmith, William A.; Bolch, W. Emmett; Gamble, J. F. (Univ. of Florida, Gainesville). Bioscience, 19: 623-4(July 1969).

Laboratory experiments were performed to determine the retention of ^{45}Ca, ^{137}Cs, ^{86}Rb, and ^{89}Sr by six selected Panamanian clays. The method consisted of slurrying a known quantity of clay, exposing the slurries to isotope solutions for 90 minutes, filtering the exposed slurries, and determining the retention of radioisotopes in the clay by gamma spectroscopy and liquid scintillation counting. For the six clays used the ^{45}Ca uptake was between 97 and 100%, the ^{137}Cs uptake between 96 and 100%, the ^{86}Rb uptake between 94 and 100%, and the ^{89}Sr between 96 and 100%. The implication is that the soil colloid fraction in the Panamanian study area represents a limitless reservoir capable of retaining soluble fallout radiocations that would be produced in nuclear excavation techniques, and that the radioactivity is thus likely to be bound in the plant-soil cycle and little, if any, should be leached to hydrologic outlets. (L.C.L.)

43412 BEHAVIOUR OF NATURAL RADIOACTIVE ELEMENTS IN NON-RUNNING FRESHWATER BASIN. Iskra, A. A.; Kulikov, N. V.; Bakhurov, V. G. At. Energ. (USSR), 27: 134-7(Aug. 1969). (In Russian).

Experimental data are given on the distribution and accumulation of ^{238}U and ^{226}Ra in model systems of a non-running freshwater basin: water; groundwater; groundwater plants; water plants. It was found that uranium accumulates in the biomass of plants (elodea and water milfoil), thorium — in detritus and ground (and sand), while radium is evenly distributed in the components of the water basin. Accumulation coefficients are given for the major components, which according to their accumulative ability form the following series: detritus > plants > ground. The coefficients reach their highest values (hundreds of thousands and several millions) in detritus. The intensity of accumulation of the elements by plants, detritus and ground may be represented by the series: thorium > radium > uranium. (auth)

Meteorology

Refer also to abstracts 43513, 43757, and 43779–43781.

Mineralogy and Exploration

Refer also to abstract 43255.

Oceanography

43413 (CU-2663-10) MIXING, DIFFUSION, AND CIRCULATION RATES IN OCEAN WATERS. Annual Progress Report No. 10. (Columbia Univ., Palisades, N. Y. Lamont-Doherty Geological Observatory). June 1969. Contract AT(30-1)-2663. 383p. Dep. CFSTI.

Geochemical research efforts aimed at defining the major chemical cycles in the world ocean were continued by studying the carbon cycle, by measuring the radon and radium content of the oceans in order to understand the interaction of the atmosphere and ocean surface, and by fallout studies, particularly the measurement of ^{137}Cs, ^{90}Sr, and tritium. The physical oceanography program for investigating the features of ocean circulation was carried out at six different field locations using measurements of dye diffusion, temperature and moisture content, carbon content, and surface winds. The results of these experiments are presented as separate papers. (L.C.L.)

43414 (TUBIK-14) ENERGY REQUIREMENTS AND ENERGY SUPPLY IN OCEANOGRAPHY. Bauer, U.; Beushausen,

J.; Mialki, W.; Zeisset, W. (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). May 1969. 45p. (In German). Dep. CFSTI (U. S. Sales Only).

Energy requirements for underwater vehicles and installations are compiled from several sources and specified in two categories according to their power and the duration of time for which a power supply is needed. A graphic display enables several kinds of undertakings to be distinguished by the structure of their energy demand. An estimate of future energy demands has been made. Energy sources and energy conversion systems suitable for underwater technology are reviewed briefly and certain criteria are discussed to evaluate systems for different kinds of undertakings. Prospective range of application for different systems is discussed in terms of power and duration. (auth)

43415 ON THE RESULTS OF INVESTIGATION OF THE RADIOACTIVITIES IN THE PORT-CALL BY THE U. S. ATOMIC SUBMARINE "PLUNGER" TO THE SASEBO PORT. Genshiryoku Iinkai Geppo, 14: No. 3, 16-17(Mar. 1969). (In Japanese).

The U. S. atomic submarine Plunger entered the Sasebo Port on January 30 and departed on February 1, 1969. The results of radioactivity investigations, performed in the port-call of the atomic submarine, are tabulated. With monitoring boats, on the day preceding the port-call, the whole area of the port was surveyed for radioactivity. Upon the port-call, both the pursuing and the specified port-call-time surveys were made. During the stay in the port, the vicinity of the atomic submarine and the specified courses were surveyed. Upon the departure, the pursuing and specified surveys were made. Survey personnel were stationed at the monitoring posts. The present port-call to the Sasebo Port is the 27th call to Japanese ports by U. S. atomic submarines, the first call being to the same port in November 1964. (NSA of Japan)

43416 ON THE RESULTS OF INVESTIGATION OF THE RADIOACTIVITIES IN THE PORT-CALL BY THE U. S. ATOMIC SUBMARINE "HADDOCK" TO THE YOKOSUKA PORT. Genshiryoku Iinkai Geppo, 14: No. 3, 17-21(Mar. 1969). (In Japanese).

The U. S. atomic submarine Haddock called at the Yokosuka Port on February 10 and departed on February 22, 1969. The results of radioactivity investigations performed during this port-call are tabulated. With monitoring boats, on the day preceding the port-call, upon the port-call, during the port-call, and upon the departure, port-area surveys were made. Survey personnel were stationed at the main monitoring posts. The total number of port-calls by U. S. atomic submarines in Japan including the present one is 28, the first one being in November 1964. (NSA of Japan)

43417 ON THE RESULTS OF INVESTIGATION OF THE RADIOACTIVITIES IN THE PORT-CALL BY THE U. S. ATOMIC SUBMARINE "PLUNGER" TO THE YOKOSUKA PORT. Genshiryoku Iinkai Geppo, 14: No. 2, 14-16(Feb. 1969). (In Japanese).

The U. S. atomic submarine Plunger entered the Yokosuka port on January 13 and departed four days later. Preceding the day of port-call, the specified courses in the port were surveyed as to radioactivities with monitoring boats. Upon the entrance, during the stay, and upon departure the specified courses about the port were surveyed. Survey personnel were also stationed at the monitoring posts. No abnormalities in radioactivities were observed by the investigation with monitoring equipment and pulse-height analyzers during the port-call of the atomic submarine. The present port-call is the 25th in Japan by U. S. atomic submarines, the first being in November 1964. (NSA of Japan)

Seismology

43418 (AD-682726) PROJECT PRE-GONDOLA II SURVIVAL OF HYPOTHETICAL PREEMPLACED CHARGES. Final Report. Joachin, Charles E. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Nov. 1968. 31p. CFSTI.

Stress and particle velocity (horizontal and vertical) data were obtained from a 140-ton nitromethane row-charge detonation in a saturated clay-shale. The charge row consisted of two 40-ton and three 20-ton charges placed in a row with 80 ft between each charge. The charge line ran S 10 deg. W from the center of the existing Pre-GONDOLA I Charlie crater with the first charge 105 ft from the center. Three sand-filled survival holes 80 ft apart were located in line with the charge row at the south end, the first hole being 105 ft from the closest charge. Gages were placed at depths varying from 60 to 70 ft in the survival holes. The unsaturated sand in the survival holes had a much lower impedance (rho c) than the surrounding Bearpaw clay-shale. This impedance mismatch resulted in a reflective interface that greatly reduced the incident stress and motion measured at the survival hole gages. Initial peak horizontal velocity, input from charges H and I (approximately 60 tons), compares well with the 20-ton charge data obtained from Pre-GONDOLA I and the main gage line of Pre-GONDOLA II. The closest survival hole (J) appears to have sustained damage, although additional data would be required to assess the extent. The remaining two survival holes (K and L) appear to have sustained light damage but would be usable. (auth) (USGRDR)

43419 (JAB-99-47) MOTION PERCEPTION IN THE LOW-FREQUENCY RANGE. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). July 1969. Contract AT(26-1)-99. 45p. Dep. CFSTI.

The results of human threshold-of-motion perception tests in the 1 to 5 sec period range are presented. Parameters which affect motion perception are the individual test subject, the period of motion, and the configuration of the test subject. Previous investigations had not included motion in frequencies above 1.0 sec. Because the natural fundamental mode periods of tall buildings and other large structures are usually longer than 1.0 sec, it is important to identify perception thresholds in the period range. Test results at and above 1 sec periods were compared with results of other investigations of threshold of human perception. The threshold of perception (in terms of acceleration) increases with frequency of motion, but approaches a constant value of 0.002g at long periods (>1.0 sec). Acceleration was found to be the best parameter for motion perception. (auth)

43420 ON THE EARTHQUAKE-PROOF DESIGN OF ATOMIC POWER STATIONS. Akino, Kinji (Japan Atomic Power Co., Tokyo). Denki Hyoron, 54: 87-91(May 1969). (In Japanese).

No atomic power station has encountered a great earthquake, and therefore no major hazards due to earthquakes have yet been experienced. When occurring, however, the situation is varied, ranging from the operating condition itself to the radioactive contamination. In the anti-earthquake design of atomic power stations, consideration of the degree of hazard vs the electricity-generating cost is involved. When the design is executed, the maximum possible and the assumed earthquakes must be determined; if the latter is assumed to be 1.5 times as large as the former, only the greatest earthquake needs to be considered. The seismic effects are transmitted from the earthquake to the building, then to the instruments, piping, etc. A model of the dynamic eigenvalues was determined, and the response analysis is given. (NSA of Japan)

43421 SIGNATURE RECOGNITION FOR NUCLEAR DETONATIONS. Vander Lugt, A.; Mitchel, R. H. (Univ. of Michigan, Ann Arbor). Opt. Acta, 16: 453-61(1969).

Experiments were performed on the recognition of nuclear detonations by using coherent optical data-processing systems. The data, comprising E-field signals recorded with a 10 kHz bandwidth, were available from only ten events, all airdrops. Since the signals were of an unknown form, they were classified into subgroups by using a cross-correlation technique. Spatial carrier-frequency filters, constructed for these signals, were then tested to determine their ability to recognize all ten signals while rejecting noise from atmospheric sources. The experiments, although of a preliminary nature, showed that all the test signals could be recognized with a two-channel filter and that the nearest noise peak (from six samples) was 6 to 8 dB less than the minimum correlation peak from any of the ten signals. (auth) (UK)

43422 SPECTRAL AND CORRELATION ANALYSIS OF GROUND-MOTION ACCELEROGRAMS. Liu, S. C.; Jhaveri, D. P. (Bell Telephone Labs., Whippany, N. J.). Bull. Seismol. Soc. Amer., 59: 1517-34(Aug. 1969).

The autocorrelation function and the power-spectral density function of twelve strong-motion earthquake and three underground nuclear explosion accelerograms were obtained using a digital computer. The physical implications of the results and their application in modeling ground accelerations were studied. Simulations by the spectral approach, using filtered stationary processes, and simulations by the correlation approach, using linear, particularly autoregressive processes, are discussed in some detail. (auth)

43423 USE OF SOURCE ARRAYS IN STUDIES OF REGIONAL STRUCTURE. Niazi, Mansour (Univ. of California, Berkeley). Bull. Seismol. Soc. Amer., 59: 1631-43(Aug. 1969).

Seismograms of 26 underground explosions and two cavity collapses at the Nevada Test Site (NTS) and 26 well-recorded earthquakes in central California recorded by a vertical instrument at Berkeley were studied. It was demonstrated that the use of source arrays instead of instrument arrays may provide information of general nature about the crust-upper mantle structure. The method can be particularly useful in regional recon-

naissance of seismic areas with as few as a single recording instrument. Times of four consistent arrivals on the NTS seismograms were analyzed. The first two arrivals with observed apparent velocities of 8.51 ± 0.47 and 6.41 ± 0.23 km/sec were interpreted as P_n and P_g phases, respectively. A later arrival, named $P_L P$, with an observed slope corresponding to a velocity of 9.80 ± 0.86 km/sec was consistent with P-wave reflections from a depth of 227 ± 22 km. The observed phases on the seismograms of central California earthquakes suggest a single-layer crust with an average thickness of 20.5 km to the south of Berkeley. The crustal-longitudinal and shear velocities are 5.87 ± 0.05 and 3.46 ± 0.05 km/sec, respectively. The observed P_n and S_n velocities were 7.91 ± 0.12 and 4.40 ± 0.10 km/sec, respectively. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 43400, 43403, 43411, 43418, 43419, 43421–43423, 43434, 43440, and 43485.

43424 (PNE-R-4) EFFECTS EVALUATION FOR PROJECT RULISON. (Nevada Operations Office (AEC), Las Vegas). June 1969. 39p. (NVO-43). Dep. CFSTI.

The hazards that might result from the detonation of a 40 kt underground nuclear charge to be used in Project Rulison were evaluated. These include both seismic effects and possible radioactive contamination of the environment. A summary of the predicted effects and recommendations for the safety of all personnel, animals, and property in the area is presented. (L.C.L.)

43425 (UCRL-50604) CONTAINMENT OF BURIED NUCLEAR EXPLOSIONS. Rapp, E. G. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1968. 20p. Dep. CFSTI.

The mechanisms that lead to a release of radioactive contaminants (venting) are discussed. The processes that appear to be of primary concern in dynamic venting are uncontrolled cavity growth toward the free surface, energy flow through large diameter openings, and upward displacement of cavity gases during chimney formation. For Plowshare experiments, the first and the last become the controlling mechanisms for dynamic venting. Logically derived models based on a fundamental physical understanding of these mechanisms are presented. These models provide an initial step toward developing criteria which assure that dynamic venting through the ground will not occur. (auth)

43426 (USGS-289-1) POTENTIAL APPLICATIONS OF NUCLEAR EXPLOSIVES TO THE RECOVERY OF GEOTHERMAL ENERGY. Progress Report for Fiscal Year 1965. Geothermal Energy-1. Waldron, Howard H. (Geological Survey, Denver, Colo.). June 1969. Contract AT(04-3)-289. 18p. Dep. CFSTI.

The initial phase of study and the utilization of nuclear explosives for stimulating and beneficiating the recovery of geothermal energy have been directed toward fundamentals that may control or influence the occurrence and character of geothermal areas. Some characteristics of heat flow and of geothermal districts are summarized; the occurrence and distribution in the United States of the more than 1,300 thermal spring localities, indicative of geothermal districts, are reviewed. Future work will include broad regional studies in the Western United States, and detailed studies of one or more selected geothermal districts. (auth)

43427 (USGS-289-2) POTENTIAL APPLICATIONS OF NUCLEAR EXPLOSIVES TO THE RECOVERY OF GEOTHERMAL ENERGY. Progress Report for Fiscal Year 1966. Geothermal Energy-2. Waldron, Howard H. (Geological Survey, Denver, Colo.). June 1969. Contract AT(04-3)-289. 17p. Dep. CFSTI.

Studies during fiscal year 1966 included some library research and consultations, a brief reconnaissance of the potential of several thermal areas in Oregon, Nevada, and California, and a brief geologic reconnaissance of the Coso Thermal Area in southern California. It was concluded that too little is known at the present time about geothermal heat and energy to permit an adequate evaluation of the feasibility of utilizing nuclear explosives for the recovery of geothermal energy. Research and investigations currently in progress, however, should greatly advance knowledge on geothermal heat and energy within the next few years. (auth)

43428 RECOVERING OIL FROM NUCLEAR CHIMNEYS IN OIL-YIELDING SOLIDS. Parker, Harry W. (to Phillips Petroleum Co.). U. S. Patent 3,460,620. Filed June 12, 1967.

Air or other oxygen containing gas is injected into the lower portion of a previously retorted nuclear chimney to burn coke and raise the temperature therein to a level at which the compressive strength of the shale rubble is substantially reduced. Reduction of the compressive strength of the shale results in compaction of the spent shale and consequent loss of support of the roof of the chimney, causing sloughing of raw shale onto the retorted mass where it is then retorted by hot combustion gases rising through the rubble. (Offic. Gaz.)

Facilities and Equipment

Refer also to abstracts 43456, 43477, 43488, 43489, 43492, 43538, 44000, 44352, and 44363.

43429 (AERE-R-4304) FREQUENCY AND VELOCITY MEASUREMENTS OF DISTURBANCE WAVES IN ANNULAR TWO-PHASE FLOW. Hewitt, G. F.; Lovegrove, P. C. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 17p. Dep. CFSTI (U. S. Sales Only). UK 4s.

Velocity frequency data are reported for the disturbance waves in upwards annular two-phase air-water flow in a vertical tube. The data were obtained using a combination of high-speed cinephotography and film thickness recording using conductance probes. The main object of the experiments was to resolve differences which had appeared in the earlier data on wave frequency. It is concluded that these differences probably arise from the definition of the disturbance waves. It was also shown that the disturbance wave forms a complete ring around the circumference of the tube. (auth) (UK)

43430 (AHSB(S)R-161) ANALYSIS OF REPORTED BOILER EXPLOSIONS AND ITS IMPLICATIONS FOR THE SAFETY OF PRESSURE VESSELS. Phillips, C. A. G.; Smith, T. A. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 13p. Dep. CFSTI (U. S. Sales Only).

Within the described limitations and criteria for the analysis the following conclusions were reached regarding the safety aspects of boiler explosions. There was an increasing trend in the number of failures during the review period 1950 to 1965, but there are insufficient data to relate this to the overall population. The majority of failures were due to overheating, water shortage, or over-pressure. Tube failures were the common cause of trouble, whereas shell rupture was infrequent. The probable time for failure was during the early stages of service life. Further statistical information is necessary, and a subsequent survey of failures in Class I constructed vessels is proceeding. Preliminary conclusions are outlined. (auth) (UK)

43431 (AWRE-O-5/69) THE PENETRATION OF GLASS FIBRE MEDIA BY AEROSOLS AS A FUNCTION OF PARTICLE SIZE AND GAS VELOCITY. PART 1. NONRADIOACTIVE AEROSOLS. Dyment, J. (Atomic Weapons Research Establishment, Aldermaston (England)). May 1969. 33p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

Experimental determinations were made of the penetration of a heterogeneous sodium chloride test aerosol through two different fibrous filter media, a medium efficiency fibre mat and a high efficiency glass fiber paper. The experiments covered particle sizes between 0.04 and 0.5 μ diameter and gas velocities from 2.5 to 50 cm/sec. A maximum value for the penetration versus particle size function was found, varying in position from 0.12 μ down to 0.09 μ with increasing gas velocity. This peak penetration was approximately three times the average test aerosol penetration on a mass basis. It is concluded that the size distribution of the test aerosol was satisfactory for the checking of filter efficiencies. (auth)

43432 (CONF-680506–, pp 149-64) REMARKS BY ARTHUR SCHOENHAUT, DEPUTY CONTROLLER, ATOMIC ENERGY COMMISSION TO INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT. Schoenhaut, Arthur (Atomic Energy Commission, Washington, D. C.).

The basic concepts of the AEC Management Information System (MIS) are outlined. The MIS is being designed as a single integrated system consisting of many interrelated computer-based subsystems. An initial study at AEC identified 27 subsystems each supporting a functional area. A general description of all subsystems is presented and the Nuclear Materials Subsystem development progress is reviewed in more detail. (J.R.D.)

43433 (CONF-680506–, pp 165-92) UF_6 SAMPLING AND SHIPPING FACILITY. Wernecke, A. H. (Goodyear Atomic Corp., Piketon, Ohio). (GAT-T-1330).

Facilities have been provided to permit the observation of sampling, weighing, and packaging procedures for cylinders of uranium hexafluoride in the civilian special nuclear materials flows. Weighing of both full and empty UF_6 cylinders, the scales used and their precision, and calibration and test weight procedures are discussed as well as the liquefaction, homogenization, and liquid sampling steps required for analytical measurement purposes. Visitors, both foreign and domestic, can be admitted to the facility inasmuch as portions of the facilities are outside the perimeter security fencing. The facilities have been visited by representatives of Transnuclear, Sumitomo, Eldorado Nuclear Limited, and NUKEM. (auth)

43434 (HN-20-205) CONVENTIONAL EXCAVATION BY HYDRAULICKING METHODS FOR THE INTEROCEANIC CANAL. Perla, H. F.; Tierney, M. P. (Holmes and Narver, Inc., Los Angeles, Calif.). May 1969. 84p. Dep. CFSTI.

An investigation was made of the feasibility and costs of using only hydraulic methods for the excavation of an interoceanic sea-level canal along Route 17 and for the transport of all clay shale material to a disposal zone. The equipment, procedures, and time required for the hydraulic operations are described and evaluated in terms of cost. It was concluded that the hydraulic method is both feasible and economical when compared with other methods. Costs of hydraulic excavation and slurry transport including disposal for providing a 600-ft wide by 60-ft deep navigation prism are estimated as $518 million which, when reduced to unit costs, is about $0.36 per yd^3 of material excavated based on current rates. (L.C.L.)

43435 (SAN-651-100) CONDENSATE PUMP INVESTIGATION. A.E.C. Organic Rankine Cycle Technology Program. Niggemann, R. E.; Suit, L. J. (Sundstrand Aviation-Rockford, Ill.). [nd]. Contract AT(04-3)-651. 63p. Dep. CFSTI.

A program to evaluate pumps applicable to low back pressure organic Rankine cycle space power systems is described. Two pumps were fabricated and tested; one for low pressure condensate, which requires a jet pump inducer when used in space power systems, and the other for high pressure condensates typical of jet condenser systems. The efficiency of the jet condenser was found to be satisfactory. The efficiency of the pump for low pressure condensate was found to be at the lower end of the efficiency range based on previous work on similar pumps. (J.R.D.)

43436 (SC-ARPIC-1012) APPLICABILITY OF HEAT PIPES TO ENERGY CONVERSION SYSTEMS. Whiting, G.; Feldman, K. T. Jr. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 26p. Dep. CFSTI.

Supersedes and updates SC-DC-67-2003.

The heat pipe is a unique, high-flux, heat transport device which utilizes the evaporation, condensation, and surface tension of a working fluid to give it an effective thermal conductivity several thousand times that of copper. The major operating characteristics of a heat pipe are nearly perfect isothermal operation over lengths of several feet, thermal transformer operation where heat is added over a small area at high flux and removed over a large area at a low flux and vice versa, thermal power flattening where large variation in output heat flux cause very little variation in output heat flux. The heat pipe is ideally suited for energy supply, removal, and thermal control of energy conversion systems. Performance characteristics and possible applications to conventional and direct energy conversion systems for terrestrial and space use are discussed. (auth)

43437 (TID-4100(Suppl.52)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). June 1969. 46p. DTIE Free.

Twelve packages of engineering drawings and specifications are presented, and include engineering drawings for shipping containers, tandem Van de Graaff, neutron survey meter, spiral readers, air bearing spindle, pulse generator and discriminator, injection valves, and tandem pulse equipment. A subject index is included. (L.C.L.)

43438 (TID-4100(Suppl.53)) ENGINEERING MATERIALS LIST. Supplement 53. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Aug. 1969. 63p. DTIE Free.

Thirty-one packages of engineering drawings and specifications are presented for primary NaK pumps, molten salt pumps, pellet sectioning vices, syntron polishers, 4-in. aperture valve, four channel air monitor, shipping containers, incinerators, pulse shape discriminators, filters, manipulator socks, RIM loaders, GIIC fast analyzers, neutron generators, zonal centrifuges, LN_2 recovery system for "Alice," thermographs, shear test apparatus, tritium monitors, paddle wheel sampler, flux concentrators, emission monitors, precision pulsers, tube testers, thermistor temperature controllers, fringes to inches converter, fast coaxial beam cup, braille terminal device, standard vacuum notes, multi-bearing steam test rig, and flow regulating apparatus. A subject index is included. (L.C.L.)

43439 (TID-25086) EVALUATION OF IMPROVED FIRE RESISTANT GLOVE MATERIALS FOR GLOVEBOXES. A GLOVEBOX FIRE SAFETY APPLICATION. Johnson, P. E. (Factory Mutual Research Corp., Norwood, Mass.). 1969. 7p. GPO $0.25.

Samples of silicone rubber sheet and neoprene were tested by the radiant heat panel test and flame test. Results and conclusions are presented. (W.H.K.)

43440 (UCRL-71774) LAWRENCE RADIATION LABORATORY OCTOPUS SYSTEM. Fletcher, John G. (California Univ., Livermore. Lawrence Radiation Lab.). June 11, 1969. 8p. (CONF-691003-1). Dep. CFSTI.

From NOC-68 Conference, National Security Agency, Ft. George G. Mead, Md.

Elements of a computer system used to simulate nuclear explosions are described. The significant aspects of the system, named OCTOPUS, are a central file facility and teletype machines, any of which has the capability of contacting any one of the peripheral machines. (J.R.D.)

43441 (Y-1685) VACUUM PUMP EXPLOSION. Hoy, H. C.; Googin, J. M.; Schmitt, C. R.; DeMonbrun, J. R.; Stanton, W. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 2, 1969. Contract W-7405-eng-26. 28p. Dep. CFSTI.

An explosion occurred in the vacuum system of an electron-beam welder at the Oak Ridge Y-12 Plant. The actual initiating mechanism cannot be determined, but the explosion occurred in the discharge lines from the roughing pump. (auth)

43442 FUNDAMENTAL PLAN FOR THE HULL OF THE FIRST NUCLEAR SHIP. Tanaka, Mamoru (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 66, 1628-35(Apr. 1969). (In Japanese).

The gross tonnage is 8,000 tons, the reactor is a pressurized light-water cooled type, the main machinery output is about 10,000 shp, and the service speed is about 16 knots. The experimental ship propelled by a marine atomic power plant, is used for the education and training of nuclear ship crews, and the transport of special cargos. The ocean-going voyage is a maximum of 40 days. Personnel includes 20 research personnel and the crew. The transporting capacity is 1500 to 1800 tons, excluding emergency fuel, fresh water, and foodstuffs. Main dimensions are indicated. Freeboard, calculation of allowable flooded length, breakdowns of the lightweight and the dead-weight capacity, stability data, damage stability, general arrangement, ship speed, and external forces as the design indicates, are also described. (NSA of Japan)

43443 IMPROVEMENTS IN AND RELATING TO CENTRIFUGES. Salmon, Benjamin (to Commissariat a l'Energie Atomique). British Patent 1,161,465. Aug. 13, 1969. Priority date Jan. 6, 1967, France.

An improved centrifuge is described that promotes increased mechanical strength of the rotary bowl by incorporating a lateral shell and two end plates designed so that each is assembled to the shell with an interposing seal between the end plate and the seal held by circumferentially spaced studs. Each end plate and shell is assembled in an interfitting relation along a contact surface which is inclined to the axis of the bowl and along a second surface which is perpendicular to the axis. (J.R.D.)

43444 FUNDAMENTAL PLAN FOR THE MACHINERY OF THE FIRST NUCLEAR SHIP. Watanabe, T. (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen, No. 66, 1636-44(Apr. 1969). (In Japanese).

Two reactors, a light-water moderated, light water-cooled, and a pressurized-water type, have a thermal output of 36 MW. Two steam generators have an evaporation rate of 30 tons/hr. The saturated steam turbine with double reduction gear has an output of 10,000 PS × 200 rpm. The auxiliary boiler evaporation rate is 18,000 kg/hr and steam condition is 30 kg/cm^2, saturated. Two generators have a rating of 1,000 KVA (800 kW), 450 V, 60 c/sec, 3 phase, 1,800 rpm, and driven by a saturated steam turbine. The engine room is a radiation controlled area. The propulsion speed of 10 knots is assured by an auxiliary boiler. The use of saturated steam increases the weight of the machinery, reduces the performance, and necessitates the countermeasure to drain. Operating factors and safety measures are discussed. (NSA of Japan)

43445 CONTINUOUS VIEWING WINDOWS (Dec. 7, 1967) (Engineering Materials). (Dow Chemical Co., Midland, Mich.). (CAPE-1909).

23 drawings.

Devices used in vacuum deposition and welding chambers to provide better visibility and facilitate view port cleaning are described. Mylar polyester film strip is wound from one spool to another across the window opening to obtain a clean and clear view when needed. A heat shield shutter is provided for use in high temperatures. Model-C and Model-A handle-coated Mylar films are used in simple operations. Model-B is used to handle recoverable materials. (For details see TID-4100 Suppl. 54) (See also 23: 24351). (F.S.)

43446 TOOLING UP FOR NUCLEAR POWER. O'Keefe, W. Power, 113: No. 7, 62-6(July 1969).

Tools needed for the fabrication of PWR and BWR components

are larger than those required for the fabrication of HTGR components. A discussion is presented on the tools needed and their application to newer and bigger components with the oncoming change in technology to breeder reactors. On-site welding, stress-relief, and machining will increase the costs of the large components. A discussion of the measures nuclear vendors have taken to fabricate components is given. (J.C.W.)

43447 FREEZE-DRY APPARATUS (Jan. 31, 1968) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1906). 1 drawing.

This drawing describes equipment used to prepare metal oxides of Al, Eu, Hf, Pu, Th, U and mixtures thereof by freeze drying as covered in U. S. Patent 3,422,167. A metal oxide sol is jetted into a freezing medium and then dehydrated by vacuum distillation after the freezing medium is removed. The freeze dry equipment consists of an insulated vessel containing a cooling mixture with a closed vessel submerged in the cooling mixture. The closed vessel, which holds trichloroethylene or another stable low-boiling refrigerant, is provided with a support plate which collects the microspheres and prevents them from collecting at the bottom of the vessel. A dip tube is connected to a vacuum pump and extends to the bottom of the closed vessel to remove the freezing medium. Microspheres of ~300 μ which are formed in 2 to 5 seconds, are uniform in size, and free from contaminants. (For details see TID-4100 Suppl. 54) (See also 23: 10260) (F.S.)

43448 CALIBRATION FACILITY (Nov. 11, 1964) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1912).

73 drawings.

A radiation instrument calibration facility is described that consists of six vertical shielded tubes of which three contain ^{60}Co, one ^{226}Ra, and one $^{239}PuBe$ sources mounted on elevator mechanisms. The sixth tube, which is located in the floor, is for experimental use. The γ sources range from 2 m Ci to over 300 Ci and produce exposure rates above the tubes of 0.145 mR/hr to 3391 R/hr. Neutron dose-equivalent rates of 1.5 to 1250 mrem/hr are produced by neutron sources whose yields total 1.9×10^7 n/sec. The diameters of the radiation beams above the tubes are ~27 cm for γ and 36 cm for neutrons. The facility is used for routine γ, neutron, and T detection instruments calibration, evaluation of new γ and neutron survey instruments, cross-calibration of instruments, and exposure of various detectors such as film and Tl dosimeters. (For details see TID-4100 Suppl. 55) (F.S.)

43449 OMNI-DIRECTIONAL VACUUM GAGE PROBE (Feb. 25, 1969) (Engineering Materials). (North American Aviation, Inc., Downey, Calif.). (CAPE-1913).

2 drawings.

A vacuum gage, capable of movement in any direction within a vacuum system, that measures the effective or molecular pressure of the system is described. An improved vacuum seal at the entrance to the vacuum system is provided by a balljoint seal or a bellows system. A ball joint seal at the entrance to the vacuum atmosphere provides a pumpout port to prevent external air from entering the vacuum. When a bellows system is used, push rods, which enter the vacuum atmosphere, are capable of swinging (free movement) and compressing or extending the bellows and gage within the vacuum system. The inner parts of the bellows provide a passage open to the external atmosphere so that all movable components within the system operate at atmospheric pressure and the bellows provide the seal between the vacuum and the atmosphere. (For details see TID-4100 Suppl. 55) (F.S.)

43450 CENTRIFUGAL PUMP FREE-SURFACE TYPE (Mar. 11, 1969) (Engineering Materials). (North American Aviation, Inc., Downey, Calif.). (CAPE-1910).

2 drawings.

The design of a diffuser-type pump incorporating a pressurized bearing which operates in Na is presented. The pump is covered in U. S. Patent 3,431,860. The pump performs at a flowrate of 7200 gpm of Na with a 150 ft head, operates at high shaft speeds with little danger of cavitation, and can be placed at the lowest point of the flow line. (For details see TID-4100 Suppl. 55) (See also NSA 15: 4078) (F.S.)

43451 FABRICATION OF ELONGATED PRODUCTS. Asbury, J. J. (to United States Atomic Energy Commission). U. S. Patent 3,462,797. Aug. 26, 1969.

The fabrication of an elongated product from particulate material is accomplished by using a mold in an isostatic pressing assembly that is capable of neutralizing the powder-compacting force directed along planes parallel to the length of the elongated product. The mold comprises a tubulation of resilient material and relatively rigid end caps with the latter being prevented from displacement towards one another by supporting structure associated with the tubulation. (AEC)

43452 SOME ASPECTS OF LOW TEMPERATURE IRRADIATION FACILITY OF KYOTO UNIVERSITY REACTOR. Shibata, Toshikazu; Iwata, Shiro; Yoshida, Hiroyuki; Nakagawa, Masuo; Okada, Moritami (Kyoto Univ.). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 2: 89-92(1969).

The design, construction, and operation of the low temperature irradiation facility of the Kyoto University Reactor are discussed. The purpose of the facility is to make basic studies of the effects of neutrons on materials in the vicinity of 10°K. The facility consists of two major parts: an irradiation cryostat which is located in the horizontal exposure hole and a helium gas refrigeration system with a compressor, gas storage, and two helium cold traps. Methods for the measurement of the physical properties of neutron-irradiated specimens are described. (R.C.K.)

43453 USE OF CONVENTIONAL EQUIPMENT FOR STEAM GENERATION IN NUCLEAR POWER STATIONS. Bitterlich, E. Energ. Tech., 20: 241-7(Aug. 1968). (In German).

The different types of nuclear reactors are described and details of the steam generating plant are given. These include variations on the usual equipment necessary because of the larger than normal output and special reactor conditions. (UKAEA Info. Bull.)

Heat Transfer and Fluid Flow

Refer also to abstracts 43398, 43436, 44755, 45060, 45071, and 45076.

43454 (AEC-tr-6877) CONVECTIVE HEAT TRANSFER IN TWO-PHASE AND ONE-PHASE FLOWS. Borishanskii, V. M.; Paleev, I. I. (eds.). Translation of Konvektivnaya Teploperedacha v Dvukhfaznom i Odnofaznom Potokakh, Izdatel'stvo Energiya, Moskva-Leningrad, 1964. 404p. (TT-68-50328; IPST-Cat.-5137). Dep. CFSTI.

A collection of papers is presented dealing with various problems related to heat transfer and resistance in two-phase and single-phase flows. Experimental results are presented along with findings of theoretical studies. Data correlations are carried out for selected problems. (J.R.D.)

43455 (ALO-3632-41) RESEARCH AND DEVELOPMENT IN A THERMAL INSULATION STUDY. Quarterly Progress Report, March-May 1969. Grunert, W. E.; Morihara, H. (Union Carbide Corp., Indianapolis, Ind. Linde Div.). Contract AT(30-1)-3632. 51p. Dep. CFSTI.

Updated results of long-term stability tests on the 1800°F composite and nickel opacified quartz multi-layer insulation systems are presented. Performance deteriorations, ranging from 6% on the 1800°F composite (1000-hours operation) to 16% on the nickel opacified system (6000-hours operation), have been noted. Potential causes and subsequent investigation of this long-term deterioration are discussed. The retest program on aluminum-glass multi-foil and glass fibrous multi-layer insulations is complete. Apparent thermal conductivity data (K_a) are presented at various temperatures and compressive loads. Thermal behavior of this class of multi-layer insulations is discussed. The 2500°F testing of the molybdenum-zirconia ($Mo-ZrO_2$) multi-foil insulation will be conducted in the next quarter. The flat plate thermal conductivity test program is nearing completion. A final review, re-evaluation and summary of the K_a-data for the various multi-layer systems are planned. The current status of the penetration effects test program is discussed. Testing difficulties have been traced to excessive interface resistance between the lead telluride penetrations and system thermal boundaries. Design changes to alleviate this problem are described. Additional testing with the modified samples is planned for the next quarter. (auth)

43456 (ANL-7504) PRESSURE RECOVERY OF A ONE-COMPONENT TWO-PHASE FLOW IN A TWO-DIMENSIONAL DIFFUSER. Korstanje, Hugo P. (Argonne National Lab., Ill.). Jan. 1969. Contract W-31-109-eng-38. 72p. Dep. CFSTI.

Performance characteristics were studied and efficiency data were obtained for one-component two-phase-flow diffusers with an area ratio of two. The optimum pressure recovery for these diffusers was reached with an angle of divergence of 15° for void fractions greater than 20%. This phenomenon and the rapid decrease of the efficiency with increasing void fraction and mass flowrate are explained with the hypothesis that the boundary-layer thickness in a two-phase flow is dependent on the void fraction. For a mass flowrate of 0.46 lb/sec, the optimum efficiencies of the subsonic diffuser were 70, 64, and 51% for void fractions of 20, 40, and 60%, respectively. For a mass flowrate of 1.26 lb/sec,

the efficiencies were 58, 31, and 8% for void fractions of 20, 40, and 50%, respectively. (auth)

43457 (CONF-670990-1) DETERMINATION OF THE LEIDENFROST TEMPERATURE. Cumo, M.; Pitimada, D. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from paper presented at 22nd National ATI Congress, Rome, Italy, Sept. 1967. 34p. Dep. CFSTI (U. S. Sales Only).

When a heating wall at a very high temperature is cooled by a jet of atomized liquid the minute drops rebound without wetting the wall, with only a slight cooling action. At low temperature, on the other hand, the drops wet the wall with a considerable cooling effect. There exists an intermediate temperature, which is called the Leidenfrost temperature, at which this change in the mode of cooling occurs. The Leidenfrost temperature can be clearly shown by recording graphically the cooling curves of the wall since it separates two sections with different slopes: one section of slight slope at high temperatures and a section with steep slope at lower temperatures. With a suitable experimental system over 200 cooling curves have been recorded and in the case of nozzle nebulization of a jet of water impinging on a nickel wall a Leidenfrost temperature of 257°C has been found. Probably such a temperature depends on parameters such as the size and speed (u) of the incident drops, pressure, and nature of the liquid and of the heating wall. Simple reasoning makes it clear that the difference between the Leidenfrost temperature T_L and the saturation temperatures T_s is connected by the proportionality relation: $T_L - T_s \propto u^5$. (auth)

43458 (GAMD-8656) DYNAM: A DIGITAL COMPUTER PROGRAM FOR STUDY OF THE DYNAMIC STABILITY OF ONCE-THROUGH BOILING FLOW WITH STEAM SUPERHEAT. Efferding, L. E. (Gulf General Atomic, Inc., San Diego, Calif.). June 26, 1968. Contract AT(04-3)-633. 116p. Dep. CFSTI.

A preliminary dynamic analysis has been developed for the study of once-through boiling flow oscillations. The analysis is intended for use as a design tool to avoid the inception of these self-excited oscillations. Studies of a modular steam generator design indicate that a relatively small amount of orificing is required at a full and part load to dampen system disturbances. Also reported are preliminary results of a study of system parameters. The purpose of the code development was first to extend an existing description of a boiling channel into the once-through regime with steam superheat, and second to develop the framework for a complete description of supercritical pressure operation. The model describing the the superheat regime (single-phase, variable density fluid) for subcritical pressure operation is also applicable to the study of once-through operation using supercritical pressure water. The dynamic analysis solves the linearized partial differential conservation equations using Laplace transformation of the temporal terms and integration of the spatial variations. The resulting equations represent the transfer functions for each spatial node. The computer code then employs frequency response techniques to develop the system transfer function. Stability criteria used in control system theory are then applied to determine if the boiling channel is unstable, i.e., if flow oscillations will appear. (auth)

43459 (KFK-tr-288) EXPERIMENTAL INVESTIGATIONS OF LOCAL HEAT TRANSFER COEFFICIENTS IN THE RING CHANNEL AND THE INFLUENCE OF EXCENTRICITIES IN THE TEMPERATURE FIELD. Sulc, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report UJV-1813. 59p. (In German). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 21: 45296.

43460 (NYO-2930-14) STUDY OF THE MECHANISMS OF GAS SOLID SUSPENSION, HEAT TRANSFER, AND FRICTION FACTOR. Technical Report No. 123-MAE-F. Peskin, Richard L.; Briller, Richard (Rutgers-The State Univ., New Brunswick, N. J. Dept. of Mechanical and Aerospace Engineering). Jan. 1969. Contract AT(30-1)-2930. 149p. Dep. CFSTI.

A theory is presented which describes the heat transfer and friction factor changes which occur in a gas solid suspension as compared with pure gas flow. The theory introduces three variables, n_p, δ_1, and P.D. n_p is the particle number density, δ_1 the laminar sublayer thickness of the boundary layer in pure gas flow, and P.D. a particle penetration depth into the boundary layer. The penetration depth is a measure of the degree of agitation a single particle causes the boundary layer by penetrating it. The Nusselt numbers and friction factors are correlated against $n_p^{\frac{1}{3}}$ P.D.δ_1. The theory has four significant advantages over previous correlations. It is mechanistic in nature, which represents a novel approach to this problem. It correlates the data from widely varying experiments onto a single line. The theory is used to demonstrate minimum values for $n_p^{\frac{1}{3}}$ P.D.δ_1 below which no increases in heat transfer or friction factor occur for suspensions as compared with similar pure gas flows. The theory also provides physical insight into the boundary layer mechanisms which govern the transport processes and explains such well-known phenomena as the trend toward equality of suspension and pure gas heat transfer at high Reynolds numbers and the decrease in improvements in heat transfer as particle size increases. Experimental data were analyzed using the theory. The heat transfer results fell in the range of no suspension enhancement over pure gas flow. The friction factor results showed increases due to the presence of particles. (auth)

43461 (SC-CR-68-3677) STUDY OF SMALL PARTICLE ABLATION USING A FREE-FLIGHT RANGE. Final Report. Sangster, David K.; Shaw, Gerald A. (General Motors Corp., Santa Barbara, Calif. AC Electronics-Defense Research Labs.). July 1968. Contract 48-6119. 60p. Dep. CFSTI.

For Sandia Labs., Albuquerque, N. Mex.

Experimental studies of the ablation of microspheres were undertaken using spheres of sintered alumina (400 to 700 μ) and of gold (250 to 650 μ) fired from a 0.30 caliber gas gun into an instrumented flight range. Ablation of the microspheres was observed by laser shadowgraphs of the spheres in flight and by photographs of the effects of the spheres on impact plates. Changes in the experimental equipment are recommended as well as more emphasis on impact plate data for quantitative data. (L.C.L.)

43462 THE LAWS OF SIMILARITY APPLIED TO BURNOUT WITH FORCED CONVECTION FLOW. Kampfenkel, O. (Siemens AG, Erlangen, Ger.). Atomkernenergie, 14: 294 (July-Aug. 1969).

A correlation is presented for use in describing burnout with forced convection flow in vertical pipes where the hydraulic equivalent diameter equals the heated equivalent diameter. All relevant variables are considered in determining burnout scaling laws by analysis to evolve dimensionless numbers using these variables. (J.R.D.)

43463 INFLUENCE OF h-f PRESSURE OSCILLATIONS ACCOMPANYING HEAT-EXCHANGE ON CONVECTIVE HEAT TRANSFER. Kafenganz, N. L.; Fedorov, M. I. At. Energ. (USSR), 27: 148-9(Aug. 1969). (In Russian).

The effects of h-f pressure oscillations on the convective heat transfer were studied using a tube of X18N10T steel with an inside diameter of 2.3 mm and a wall thickness of 0.2 mm as a fuel element. The results of measurements taken at five points along each section showed that the h-f pressure oscillations appearing on surfaces with pseudoboiling and spreading in the liquid flow significantly improved the ordinary convective heat transfer. (R.V.J.)

43464 FLUID PROPERTIES AND HEAT TRANSMISSION BY WATER IN THE CRITICAL AREA, AND ITS APPLICATION IN NUCLEAR REACTORS. Arneodo, C. Energ. Elect., 45: 833-60(Dec. 1968). (In Italian).

Results of research on the state of investigation on thermodynamics, heat transmission, and fluid dynamics in the water-steam critical area are presented. The fluid behavior in the critical area, and thermodynamics and transmission properties are studied in the range 350 to 450°C, 200 to 300 kg/cm^2, and the analytic formulation is discussed. The correlations which are available for the calculation of heat transmission and friction coefficients are compared with the experimental results of various origin. The application of water-steam or only steam at pressures nearing the critical point (180 to 300 kg/cm^2) for cooling nuclear reactors is also analyzed. (UKAEA Info. Bull.)

Isotope Technology

Refer also to abstracts 43386, 43455, 43480, 43481, 43503, 43566, 43623, 43637, and 43965.

43465 (KFK-1002) SEPARATION NOZZLE PROCESS FOR URANIUM ENRICHMENT. Becker, E. W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). June 1969. 13p. (CONF-690530-1). Dep. CFSTI (U. S. Sales Only).

From Atomforum Conference, Utrecht, Netherlands.

In the separation nozzle process, a mixture of about 5 mole % UF_6 and 95 mole % He is expanded through a slit-shaped nozzle. Operation of a 10-stage pilot plant for this process is described. A method for inexpensive mass production of separation nozzle systems was developed. Economic aspects are discussed. (M.C.G.)

43466 (MLM–1655) SELF-ABSORPTION AND ENERGY SPECTRUM DISTORTION OF ALPHA PARTICLE EMISSION FROM MICROSPHERICAL SOURCES. Kershner, C. J. (Mound Lab., Miamisburg, Ohio). Aug. 22, 1969. Contract AT-33-1-GEN-53. 10p. Dep. CFSTI.

Relationships were derived based on fundamental geometrical factors and with a minimum of assumptions which can be used to describe or predict the energy spectrum and effective emission of α-particles from a microspherical source. The calculated values using the derived relationships and experimental data for $^{238}PuO_2$ microspheres are in good agreement. (auth)

43467 (NP–17939) SAFETY ASPECTS OF LAUNCHING SATELLITE VEHICLES CARRYING RADIOISOTOPIC POWER GENERATORS. (Department of Supply, Canberra (Australia). Australian Atomic Energy Commission, Coogee). 1969. 38p. Dep.

General safety aspects of possible applications of radioisotopic power generators in ELDO launch vehicles EUROPA I and II in the 1970's are discussed. Missions would require 5 to 500 W for 1 to 5 years, to power electrical equipment in unmanned satellites. Fuels considered are ^{90}Sr, ^{238}Pu, and ^{227}Ac. Principles of radioisotopic generators are discussed briefly. Hazards considered are those arising in transport, storage, loading, launch, orbit, and re-entry phases. Special mention is made of recovery of isotopic fuel after the flight phase. Safe launching of ELDO vehicles with radioisotopic generators is feasible; additional restrictions required are not prohibitive. The recommendations, including that of a capsule design for intact re-entry survival, should be considered at the system design stage. Detailed consideration of re-entry from a delaying orbit was not made. (Australia)

43468 (PB–184095) RADIUM SOURCE INTEGRITY TESTING. Progress Report. Pettigrew, George L. (National Center for Radiological Health, Rockville, Md.). Feb. 1967. 11p. (MORP–67–3). CFSTI.

Limited data are collected from radium source testing. Source leakage and surface contamination, source decontamination, and destructive bending of sources are included. Scope of additional testing of source integrity is discussed. (auth) (USGRDR)

43469 (WANL–3800–33) SNAP 23A, PHASE 1. Quarterly Progress Report, March 1–May 31, 1969. Wilgus, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). June 1969. Contract AT(30–1)–3800. 94p. (WANL–PR–SS–28). Dep. CFSTI.

Testing of the experimental mockup system continued during the period. A safety analysis was completed for use with the application for the heat source shipping license. Stress analysis of the fuel capsule was completed. Life testing of thermal insulation Min-K 2000 and Min-K 2002 continued during the period. Other activities are also reported on program management and liaison engineering. (J.R.D.)

43470 SEPARATION OF ISOTOPE MIXTURE IN A TWO-DIMENSIONAL SUPERSONIC JET. Mikami, Hisashi (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 6: 452–7(Aug. 1969).

A numerical analysis is presented on the separation of UF_6 isotope mixture in a supersonic jet from a two-dimensional sonic nozzle, based on the kinetic theory of gas in the continuum region. The results of calculation for the diffusion flux are found to be in fairly good agreement at low Knudson numbers with the results of experiment given by Becker et al. (auth)

43471 A PROVED DESIGN FOR AN EMANATING RADIOTHORIUM SOURCE HOLDER. Poole, D. H.; Warner, A. G. (Central Electricity Generating Board, Berkeley, Eng.). J. Phys., E (London), 2: 820–2(Sept. 1969).

A design for a radiothorium source holder is described. Such a holder was successfully used over a long period to produce a large number of secondary ThB surface sources. (auth) (UK)

Materials Testing

Refer also to abstracts 43492, 43937, 43962, and 44007.

43472 (ANL–7493) STRENGTH-DEFORMATION CONSIDERATIONS OF AN INVOLUTE SHELL. Marchertas, A. H. (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

An exploratory analysis is made of the behavior of a thin, cylindrical, involute shell subjected to a steady-state pressure and internal thermal gradients (which vary along the involute). Five theoretical approaches are adapted to the one-variable, involute shell problem, and solved explicitly for the dependent variables of internal loads and displacements. Small-deflection theory is used throughout. Each approach was used to solve two numerical problems, one involving uniform transverse pressure imposed on the shell, and the other subjecting it to isothermal expansion. In both problems, three boundary conditions were employed: fixed, pinned, and what is referred to as rotated edges. Quantitative differences between the respective solutions are discussed. Similar comparisons are made with available experimental data. (auth)

43473 (ANL–7551) ANALYSIS OF MAGNETIC FIELDS IN A METAL. Waidelich, D. L. (Argonne National Lab., Ill.). May 1969. Contract W-31-109-eng-38. 15p. Dep. CFSTI.

In the nondestructive testing of metals, experimental measurements had shown that the attenuation of electromagnetic waves originating from a masked probe and passing through a thin sheet of metal was much less than that predicted by the use of a mathematical model employing plane waves with the pulsed magnetic vector parallel to the surface of the metal. An analysis was made by assuming that the pulsed magnetic vector was perpendicular to the surface of the metal. The results of both analyses indicated that the attenuation in the metal was the same and was very nearly equal to the attenuation observed experimentally. The plane-wave analysis with the magnetic vector parallel to the metal surface, however, would require a large attenuation at the air-to-metal and the metal-to-air boundaries, whereas the analysis with the magnetic vector perpendicular to the metal surface would probably require very little attenuation at these surfaces. These findings seem to indicate that the observed difference is caused by the reflections occurring at the air-to-metal and the metal-to-air boundaries, and that the analysis with the magnetic vector perpendicular to the surface of the metal will predict very nearly the attenuation observed experimentally. (auth)

43474 (CONF–680506–, pp 141–8) NEUTRON RADIOGRAPHIC TECHNIQUES AS A TOOL FOR NUCLEAR MATERIALS SAFEGUARDS. Boland, J. F. (Argonne National Lab., Idaho Falls, Idaho).

A few fuel samples have been neutron radiographed at the Transient Reactor Test Facility (TREAT) to explore the feasibility of using radiography techniques for measuring the fissile content of reactor fuel elements. These preliminary measurements indicate that the ^{235}U content in flat-plate and pin-type elements with enrichments in the range of 10% can be determined to an enrichment accuracy of about 0.5% if a standard of known enrichment is available for exposure with the unknown. For enrichments in the range between 30 and 90%, the accuracy is considerably less but should be better than 5%. Neutron radiography techniques could be used for enrichment analyses on spent reactor fuel elements or elements from fuel reprocessing systems which do not remove the majority of the fission products. Therefore, these techniques could be applied when gamma radiation levels prevent the use of gamma spectrometry for safeguards inspections. (auth)

43475 (CONF–680506–, pp 205–20) NONDESTRUCTIVE ASSAY OF ZPPR FUEL. Perry, R. B.; Brandenburg, R. W.; Beyer, N. S. (Argonne National Lab., Ill.).

The Zero Power Reactor facility will require a fuel inventory of 3,000 kilograms of plutonium consisting of more than 15,000 fuel elements. The fuel elements are 2″ × 4, 5, 6, 7, or 8″ × 1/4″ thick rectangular plates jacketed in 304 stainless steel 0.015″ thick. The plutonium fuel is in the form of a ternary alloy 69.3 wt % depleted uranium, 28.2 wt % plutonium, and 2.5 wt % molybdenum. The plutonium is 86.6% ^{239}Pu, 11.5% ^{240}Pu, 1.7% ^{241}Pu and .2% ^{242}Pu. The nondestructive assay of ZPPR elements for ^{239}Pu by gamma ray spectrometry is being done for accountability purposes. A computer operated system that handles up to 48 elements at a time is being used for the nondestructive assay. The equipment has been handling approximately 1,000 elements per month. (auth)

43476 (ORNL–TM–2655) ULTRASONIC FREQUENCY ANALYSIS. Whaley, H. L.; Cook, K. V. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 25p. (CONF-691005–1). Dep. CFSTI.

From 29th National Convention on American Society for Nondestructive Testing, Philadelphia, Pa.

In order to increase understanding of frequency effects in ultrasonic testing, a system was developed which can analyze the frequency content of reflected or transmitted ultrasonic pulses. The system is composed of commercially available electronic equipment and can be used with conventional ultrasonic instruments operating in either a contact or immersion mode. The system was used to examine the frequency effects of the following ultrasonic

test variables: transducer type, ultrasonic instrument type, transducer positioning, tuning devices, and collimation. (auth)

43477 (SCL-DR-69-44) NUMERICAL PREDICTIONS OF THE MOTION OF MAGNETICALLY ACCELERATED FLYER PLATES. Reynolds, R. W.; Jacobson, F. S. (Sandia Labs., Livermore, Calif.). July 1969. Contract AT(29-1)-789. 42p. Dep. CFSTI.

Capacitor banks have been successfully used to accelerate flyer plates for impulse testing. The predictions of the motion of the flyer plate should be of considerable assistance in the design of capacitor banks and flyer plates. The motion of the flyer plate was studied with the aid of a circuit equation and an equation of motion. These two equations were derived in general, applied to a flat flyer geometry, and then solved numerically using a Runge-Kutta technique. A series of experimental tests was conducted with a capacitor bank. The results of these tests were in very good agreement with the numerical predictions. (J.C.W.)

43478 (UCRL-71605) STATISTICAL THEORY OF DESIGN FOR PLATING THICKNESS MEASUREMENTS BY RADIATION BACKSCATTER METHODS. Fox, Jerry D.; Taylor, Grover M. (California Univ., Livermore. Lawrence Radiation Lab.). July 1, 1969. 33p. (CONF-691005-2). Dep. CFSTI.

From 29th National Convention on American Society for Nondestructive Testing, Philadelphia, Pa.

The application of statistical experimental design techniques to methods of plating thickness measurements such as x-ray fluorescence and beta-radiation backscatter is described. Factors discussed include number of standards, accuracy of standards, thickness range, and accuracy of radiation measurements for both the standard and the unknown thicknesses. A least-means-squares technique is applied for fitting the calibration curves, and analytical techniques are used to study the effect of variations in the above factors on the final uncertainty in determination of the unknown thicknesses. Tabulated experimental and theoretical data are included for guidance in designing nondestructive testing programs that use these techniques. (auth)

43479 INDUSTRIAL RADIOLOGY. Rumyantsev, S. Russian Monographs and Texts on Advanced Mathematics and Physics. New York, Gordon and Breach, Science Publishers, [1969]. 279p.

Translated from the Russian by S. Semyonov.

Information in the book is presented in four parts. A separate abstract was prepared for each part. (J.R.D.)

For abstracts of individual sections see: 43480, 43481, 43791, and 43937.

43480 PHYSICAL AND ENGINEERING FUNDAMENTALS. pp 7-68 of Industrial Radiology. Rumyantsev, S. New York, Gordon and Breach, Science Publishers, [1969].

Information is presented on atomic structure, electron shells, isotopes, natural radioactivity, artificial radioactivity, decay, specific activity, radiation dose, radiation sources, alpha-absorption, beta-absorption, gamma radiation effects, gamma attenuation, and radiation sources used in industrial radiography. (J.R.D.)

43481 METHODS OF INDUSTRIAL RADIOLOGY BASED ON THE USE OF RADIOACTIVE RADIATION. pp 69-209 of Industrial Radiology. Rumyantsev, S. New York, Gordon and Breach, Science Publishers, [1969].

Methods and equipment used in gamma radiography are described. Information is included on metal flaw detection by radiography, xeroradiography, ionization, and metal vision. (J.R.D.)

43482 FIXATION OF PHOTOELASTIC-FRINGE PATTERNS BY γ-RAY. 4. DEPENDENCE OF THE AMOUNT OF RESIDUAL FRINGE PATTERNS ON TEMPERATURE AND AN EXPERIMENT TO FIX THE THERMAL STRESS. Miyazono, Shohachiro; Sakamoto, Fumio (Japan Atomic Energy Research Inst., Tokai). Nippon Kikai Gakkai Rombunshu, 35: 31-9(Jan. 1969). (In Japanese).

A summary of previous thermo-photoelastic experiments is given. The application of gamma fixation phenomenon of photoelastic fringe patterns to the fixation of steady thermal field was investigated. Cooling from normal temperatures was used to establish a temperature gradient. The material with the weight ratio of epoxy resin and setting agent of 100 : 12 was subjected to a mechanical load, and was irradiated at low temperatures in that condition. The rate of residual photoelastic fringe patterns was small as the temperature became lower. The linear expansion coefficient, the elastic constant, and the photoelastic sensitivity of unirradiated and irradiated materials were measured, and it was found that this material can be used satisfactorily for thermo-photoelastic experiments. In an irradiation experiment in which the high energy linear electron accelerator was employed, the high dose rate was obtainable, but the attainment of the expected aim of the experiment was difficult due to uneven distribution of γ-ray intensity and heat generation by absorption of electron beam. (NSA of Japan)

43483 USE OF SMALL ACCELERATORS, NEUTRONS GENERATORS FOR NEUTROGRAPHY. Berthod, J.; Breynat, G.; Dubus, M.; Vu Hong, L. Bull. Inform. Sci. Tech. (Paris), No. 137, 23-32(May 1969). (In French).

Neutron radiography testing carried out with small accelerators (neutron generators) is discussed. The first experiments defined the best conditions of fast neutron thermalization. With the moderator assembly, neutron radiography images are obtained by the methods used with reactors (transfer method). The direct exposure method is also usable, either with a gadolinium converter, or with scintillators. Some other nondestructive testing possibilities with fast neutrons are being studied. (auth)

43484 FILMING OF POWER CABLES AND THEIR ATTACHMENTS BY γ-RAY RADIOGRAPHY. Shimizu, Naoyuki; Manabe, Katsumi (Furuka Electric Co., Tokyo). Denki Hyoron, 54: 579-85(Apr. 1969). (In Japanese).

A gamma radiographic method for nondestructive inspection of large power cables and their attachments is described. The characteristics of γ- and x-rays and the method by which gamma radiation is transmitted are described. The application of this method for inspection of 154 KV.-POF cables is shown. The changes in the parts of cables by the short-circuit test were examined by comparing the γ radiation (from ^{60}Co) films obtained before and after the test. Also, x-ray and γ-radiation films for the same part were compared, and the x-ray film was foggy, but the γ film was sharp and clear. (NSA of Japan)

Protective Structures

43485 (CEX-68.3) NUCLEAR WEAPONS EFFECTS TESTS OF BLAST TYPE SHELTERS. A Documentary Compendium of Test Reports. Beck, Christian (comp. and ed.) (Division of Biology and Medicine (AEC), Washington, D. C. Civil Effects Branch). June 1969. 414p. Dep. CFSTI.

The results of 37 different tests for evaluating personnel shelters exposed to the blast effects of nuclear detonations are summarized. Included in the types of shelters are: family and communal; underground, above ground, and naval structures; and wood, steel, and reinforced concrete construction. French and German test results for underground shelters were compared with test results from the USA. A brief set of recommendations based on the compiled data is presented. (L.C.L.)

Radioactive Material Handling

Refer also to abstracts 43407, 43409, 43432, 43433, 43474, and 45096.

43486 (AERI-31) USE OF KOREAN CLAY MINERALS IN THE TREATMENT OF RADIOACTIVE LIQUID WASTES. Lee, Sang Hoon; Kim, Seung Nam; Kim, Yong Eak; Cho, Chong Ung; Kang, Woong Ki (Atomic Energy Research Inst., Seoul (South Korea)). [1969]. 24p. Dep.

In 1964 a three-stage liquid waste treatment facility which used domestic clays for the adsorption of radioisotopes such as ^{137}Cs and ^{90}Sr was constructed near the Atomic Energy Research Institute in Seoul, Korea. Experimental procedures are described which were used to determine the characteristics of the selected clays, to pretreat the clay samples, and to measure the radioisotope uptake. It was concluded that: the surface characteristics of the clay minerals could be determined as a function of their pH; after heat, acid, and alkali treatments of the clays the ^{137}Cs uptake was greater than the ^{90}Sr uptake. The optimum flow rate of feed waste was also determined. (L.C.L.)

43487 (ARH-1093) PRESSURE BUILD-UP OF PLUTONIUM NITRATE SOLUTIONS IN SEALED SHIPPING CONTAINERS. Crawley, D. T. (Atlantic Richfield Hanford Co., Richland, Wash.). July 15, 1969. 22p. Dep. CFSTI.

The pressure build-up from high concentration plutonium nitrate solution containing plutonium-VI-5 M nitric acid was measured in vented polyethylene bottles sealed in pressure vessels similar to that used as shipping containers. Using plutonium nitrate solutions with the plutonium-VI concentrations varying between 10.0 and 27.0 percent, it was found that the internal pressure of the pressure vessels rose at substantially the same rate. Oxygen was the predominant gas evolved and varied directly with the amount of plutonium-VI present when the vessel was sealed. A comparison

between the test condition and that of the L-3 and L-10 shipping containers indicates sizeable pressures can be expected if plutonium-VI is present when the shipping containers are sealed. (auth)

43488 (BNWL-1066) EVALUATION OF ATOMIZING NOZZLES FOR THE SPRAY SOLIDIFICATION OF RADIOACTIVE WASTE. Kaser, J. D.; Jaech, J. L.; Buschbom, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1969. Contract AT(45-1)-1830. 33p. Dep. CFSTI.

Several atomizing nozzles were evaluated for use in the spray solidification process for radioactive waste by comparing spray drop size. Sprays were sampled by the drop capture method. An internal mix pneumatic atomizing nozzle was selected. For this nozzle, the mass median drop diameter in micrometers, $\overline{x}$, increased with the ratio of liquid to air volumetric flow, Q_l/Q_a according to the relation: $\overline{x} = 29400\ (Q_l/Q_a) + 18.9$. The drop sizes were distributed such that the dimensionless diameter $x^* = x/\overline{x}$ followed the special upper limit distribution: $(dv/dy) = (\delta/\sqrt{\pi})e^{-\delta^2 y^2}$ where, $y = \ln (ax/x_m - x^*)$; v = volume fraction of drops smaller than x^*; $\delta = 0.826$; $a = 1$; and $x_m = 2$. (auth)

43489 (BNWL-1117) WASTE SOLIDIFICATION ENGINEERING PROTOTYPES, DESIGN VERIFICATION TESTING OF SPRAY SOLIDIFICATION EQUIPMENT. Moore, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 95p. Dep. CFSTI.

WSEP Spray Solidification equipment which will ultimately be used for reducing liquid high-level radioactive waste to rock-like solids was tested in a series of runs with nonradioactive simulated wastes. Operable feed compositions for two Purex-type wastes were developed. Performance of each solidifier component was analyzed. Minor design changes were made and the equipment was commissioned for radioactive service. Spray solidifier operating procedures and operating limits were defined. (auth)

43490 (BNWL-1163) EFFECT OF THE PRIOR DISPOSAL OF UNCONTAMINATED SOLUTION ON THE WASTE RETENTION CAPACITY OF A HANFORD CRIB. Routson, R. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 18p. Dep. CFSTI.

An empirical method, suggested by constant head and moisture redistribution studies, was developed to predict the movement of a wetting front and a waste front in homogeneous sand columns due to pulse solution additions. The movements of wetting fronts and waste fronts were initiated by additions of equal pulses of aqueous solution. Movement of the wetting front was initiated prior to the initiation of the movement of the waste front. Log–log plots of the frontal position versus elapsed time were found to be linear for both wetting fronts and waste fronts for elapsed times up to 5000 hours. This demonstrates that the position of a front at time T can be empirically predicted by equations of the form $S = ET^F$. Parameters E and F can be evaluated from laboratory measurements. Parameter E was found to be an extensive variable which increased with an increase in the amount of solution added as a pulse. Parameter F was found to be constant for a range of solution additions from 2.5 to 10% of the column volumes, suggesting that it may be an intensive variable. The position of the wetting front was found to move at a faster rate than the position of the waste front. Initiation of the waste front was found to increase the rate of movement of the wetting front. The observed decreased rate of movement of the waste front relative to the wetting front was interpreted as being equivalent to an increase in the waste retention capacity of the soil due to an initial addition of uncontaminated solution to the soil. In addition, moisture initially present in a soil need not be subtracted from the waste retention capacity because it will be displaced into the groundwater ahead of any disposed aqueous waste. (auth)

43491 (CEA-R-3731) USEFULNESS OF THE DECAY RATE IN THE MANAGEMENT OF RADIOACTIVE WASTE STOCKS. Rodier, Jean; Cohendy, Gerard (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). May 1969. 22p. (In French). Dep. CFSTI (U. S. Sales Only).

It became apparent, during the first few years of operation of the Marcoule Centre, that it was very useful to exploit the natural decay rate of the radioactive element contaminating the waste. The storage of this waste under the best possible conditions in each case was favorable from the radiological safety point of view and it led to a marked reduction in the cost price since it was possible to avoid using protection means that would have proved to be excessively over sized after a few years. Finally, even when the half-life of the radioelements involved seemed to preclude any possible advantages of this method, the temporary storage made it possible to develop treatment processes which were unknown at the time. The overall result of this policy was that, at the present time, over 98% of the solid waste produced by the Marcoule Centre has been processed in such a way that it can, at any moment, be discharged from the site without difficulty.

43492 (CONF-680506) INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT NINTH ANNUAL MEETING, CHICAGO, ILLINOIS, MAY 13–15, 1968. (Institute of Nuclear Materials Management, Columbus, Ohio). 220p. Institute of Nuclear Materials Management, Columbus, Ohio $6.50.

A total of seventeen papers were presented at the meeting. A separate abstract was prepared for each of fifteen papers. Two papers were previously abstracted in NSA as 22: 27531 and 22: 47073. (J.R.D.)

For abstracts of individual papers see: 43432, 43433, 43474, 43475, 43493–43502, and 43955.

43493 (CONF-680506–, pp 1-8) UTILITY'S VIEWPOINT OF NUCLEAR FUELS MANAGEMENT. Behnke, W. B. (Commonwealth Edison Co., Chicago, Ill.).

A review of nuclear materials use by Commonwealth Edison in production of electric power is presented. Discussions are included concerning supply of nuclear fuel, fuel management, and future trends in fuel management. The whole fuel cycle is examined along with aspects of management such as purchasing, inventory, costing, and cycle optimization. (J.R.D.)

43494 (CONF-680506–, pp 9-17) APPLICATION OF GENERALLY ACCEPTED AUDITING STANDARDS AND AUDITING PROCEDURES TO EXAMINATIONS OF NUCLEAR MATERIALS RECORDS AND REPORTS. Smith, Bruce F. (Price Waterhouse and Co., New York).

A brief review is presented of the auditing standards and procedures used by Certified Public Accountants (CPA) in making an examination and on which materials accountability opinions are based. While the standards were adopted for financial statements, they can be applied in some measure to all unitarity accounting systems and reports. The major procedures employed in making audits are examined revealing that they are the same procedures a chemist, physicist, or engineer would have to use were he to make an audit or examination. The talents the CPA brings to his work are recognized and the technical talents he does are considered. It appears that the opinions expressed by CPA's on nuclear materials records and reports is one on which owners, lessors, and regulatory agencies may reasonably rely. (auth)

43495 (CONF-680506–, pp 19-27) SIGNIFICANCE OF OFFICE OF SAFEGUARDS AND MATERIALS MANAGEMENT ACTIVITIES TO U. S. INDUSTRY. Crowson, D. L. (Atomic Energy Commission [Washington, D. C.]).

It is noted that nuclear facilities are handling extremely expensive material of high strategic value. Careful management, protection, and accountability for these materials is obviously a sound business requirement. Prudent materials management will pay for itself and will go a long way to providing an effective safeguards system. However, careful management of the materials and satisfactory keeping of books are not enough. Protection of materials and prevention of their diversion are very important. An effective safeguards system necessitates that management—top, middle, and lower—get involved in the program and acquire an understanding of the aims of safeguards policies and procedures. Through such understanding will come an appreciation of the need to audit and check, protect, and supervise. Of equal importance is that from such understanding should come ideas—ideas from management as to how best to carry out effective safeguards with minimum intrusion. (auth)

43496 (CONF-680506–, pp 29-33) INTERNATIONAL INSPECTIONS IN THE U. S. Downing, J. J. (Division of International Affairs (AEC), Washington, D. C.).

Since 1962, under an agreement with the International Atomic Energy Agency four reactors in the United States have been inspected by that Agency. Periodic accountability and operating reports were submitted by the United States to the Agency. In August and September, 1967, the Nuclear Fuel Services, a privately owned chemical processing plant, was subjected to resident inspection by a ten-man IAEA team while safeguarded fuel from the Yankee reactor was being processed. There are presently three international organizations which carry out safeguards inspections and other control measures. They are the International Atomic Energy Agency, Vienna; Euratom, Brussels; and the European Nuclear Energy Agency in Paris. Safeguards have been applied bilaterally by the United States, Canada and the United Kingdom. Of the systems listed, only the IAEA has carried out inspections within the United States. (auth)

43497 (CONF-680506–, pp 35-42) AEC REGULATORY ORGANIZATION FOR SAFEGUARDING SPECIAL NUCLEAR MATE-

RIAL POSSESSED BY LICENSEES. Wischow, R. P. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

The Division of Nuclear Materials Safeguards, established in July 1967 and reporting to the Director of Regulation, administers safeguards for all nuclear meterials held by AEC licensees. The Headquarters staff is physically located at Bethesda, Maryland; District Safeguards Offices have been established at Newark, New Jersey, Oak Ridge, Tennessee, and Berkeley, California. The Division is responsible for promulgating licensee regulations, reviewing and approving licensees' safeguards programs including prelicensing evaluations of proposed new facilities, setting of license conditions relating to safeguards requirements, inspecting licensees' operations against regulatory requirements, and communicating with licensees concerning observed safeguards deficiencies and subsequent enforcement of regulatory requirements. After reviewing some background information, the domestic licensee safeguards program is discussed, specifically, those aspects relating to the responsibilities, the organizational functions and structure of the Division of Nuclear Materials Safeguards. Some conclusions are reached on where the program stands today and some thoughts about the immediate future. (auth)

43498 (CONF-680506–, pp 43-51) SAFEGUARDS REQUIREMENTS APPLICABLE TO AEC LICENSEES. Bloom, J. L. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

Atomic Energy Commission licensees who are authorized to possess special nuclear material (SNM) are required by Commission regulation to safeguard the material in the interest of the national security. They are required to maintain records showing receipts, transfers, and inventories of SNM and to report promptly any theft or loss of material other than normal operating losses. Additionally, they are required to submit transfer and periodic status reports to the Commission for SNM received, transferred, and possessed. Those licensees authorized to possess at any one time a quantity of SNM exceeding 5,000 grams of contained ^{235}U, ^{233}U or Pu, or any combination thereof, are required to establish and maintain written material control and accounting procedures which are sufficient to enable them to account for all SNM possessed under license and are required to perform, at least annually, a physical inventory of SNM that is possessed. Applicants for a license to possess 5,000 grams or more of contained ^{235}U, ^{233}U or Pu, or any combination thereof, in unsealed form are required to submit a full description of their procedures for control of and accounting for SNM. They are also required to identify the Fundamental Material Controls (FMC's) which they consider essential for assuring that SNM in their possession will be adequately safeguarded. Safeguards requirements, including the preparation of FMC's and supporting procedures for safeguarding SNM, are discussed. (auth)

43499 (CONF-680506–, pp 63-72) SUBSTITUTION CONCEPT IN INTERNATIONAL SAFEGUARDS. Mahy, John F. Jr. (Office of Safeguards and Materials Management (AEC), Washington, D. C.).

In international safeguards situations, the substitution of unsafeguarded material for safeguarded material can be a useful tool in meeting the requirements of both the safeguarding organization and the group being safeguarded. The concept, its development, problems, and uses are described. (auth)

43500 (CONF-680506–, pp 97-106) ROAD TO PRIVATE OWNERSHIP. Quinn, G. F. (Atomic Energy Commission, Washington, D. C.).

The transition from Government to private ownership of fuel for the nuclear power industry has occasioned the establishment of new policies and methods for distribution and management of special nuclear materials by Government and industry. Certain of these new procedures are reviewed from the standpoint of nuclear materials management. (auth)

43501 (CONF-680506–, pp 107-17) I.A.E.A. SAFEGUARDS INSPECTION AT NUCLEAR FUEL SERVICES, WEST VALLEY, N. Y. Sharpe, B. W. (International Atomic Energy Agency, Vienna (Austria)).

The preparations made in advance of the safeguards inspection at Nuclear Fuel Services at West Valley, N. Y., the conduct of the inspection operation under expected conditions, the influence of unexpected conditions, and the results are described and discussed. (auth)

43502 (CONF-680506–, pp 121-39) COMPUTERIZED CONTROL OF NUCLEAR MATERIALS FOR URANIUM RESIDUE REPROCESSING. Leist, N. R.; Kispert, R. C. (National Lead Co. of Ohio, Cincinnati). (NLCO-1017).

During the manufacture of uranium fuel cores, many types of residues are generated. The uranium values of these residues must be recovered and returned to the main uranium processing stream. Normally, these uranium values are returned to the solvent purification step; however, most of the residues require several pretreatment operations before they become amenable to the HNO_3–Tri Butyl Phosphate Extraction Process. The number and types of residues involved and the diverse pretreatment operations required multiply nuclear materials control problems and create many scheduling problems in reintroducing the uranium into the main processing stream. Several Honeywell-200 digital computer programs were therefore written and are being used to aid in the evaluation, scheduling and control of these residues. These programs, when completely linked, will eliminate many manual computations and clerical operations now required for nuclear materials control, evaluation and assignment of residues, and advanced production scheduling. (auth)

43503 (IDO–12069) INJECTION OF GAS INTO THE LITHOSPHERE AT THE NATIONAL REACTOR TESTING STATION. Schmalz, Bruce L. (comp.) (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.). June 1969. 166p. Dep. CFSTI.

Tests were conducted by injecting 1 million ft^3 of air, containing 1,000 Ci xenon-133, into a porous zone 120 feet below the land surface. The movement of this gas was studied by means of air samples and radiation detection equipment placed in surrounding monitoring wells. Air samples also were collected at the land surface and from strategic locations in the atmosphere. Analysis of the results using diffusion equations verified that the movement could be explained on this basis. Variation of estimated flux from that measured was explained on the basis of barometric influences. It was estimated that 0.5 of 1,000 Ci injected escaped to the atmosphere during a 24-day period. This amount resulted in concentrations that were less than the mean concentration of xenon-133 in the injected air by a factor of 10^8. Mathematical models describing the flow by convective forces created by injection also were tested and found adequate for making engineering estimates. (auth)

43504 (KFK–888) ANNUAL REPORT FOR ASD DECONTAMINATION, 1967. Krause, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec. 1968. 68p. (In German). Dep.

A survey of the work and operating experience of the Decontamination Division in 1967 in the fields of handling, transport, and storage of radioactive waste and the decontamination of equipment and buildings is presented. An account is given of the laboratory experiments carried out in this field with the purpose of developing new and improving known methods. (J.C.W.)

43505 (ORNL-tr–2183) PILOT PLANT FOR BITUMEN COATING OF HIGH-LEVEL CONCENTRATES. Rodier, Jean; Lefillatre, Guy; Seyfried, Philippe (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Translated for Oak Ridge National Lab., Tenn., from report CEA-R–3734. 21p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 31448.

43506 EFFECTS AND PROTECTION OF RADIATION FROM ATOMIC FACILITIES. 2. DISPOSAL OF RADIOACTIVE WASTES TO OCEAN. Hiyama, Yoshio; Shimizu, Makoto (Tokyo Univ.). Genshiryoku Kogyo, 15: No. 3, 9-13(Mar. 1969). (In Japanese).

The disposal of radioactive wastes in the ocean is especially important in Japan, because of the island country and of the fishing industry. The general nature of radioactivities is described, including environmental contamination, radiation injuries, permissible doses, internal exposures, and radioactivities in marine-product resources. Then, the following are discussed: the locations of disposal sites for radioactive wastes; ocean disposal; deep-sea disposal in coastal waters; alternative selection of deep-sea disposal and release in coastal water; non-edible fishes; fishermen's external exposure due to the contaminated fishing net and boat; sea-bathing and shell gathering; the effects on the life of marine animals; sea-water dilution; adhesion onto the suspended substances in sea-water; intake by marine life; distribution of fishing areas; egg-laying areas and sea-bathing areas; radionuclides and the marine species absorbing them; regulations for release in coastal water; the position of releases; regulations for deep-sea disposal, including the sea bottom and bottom current; and monitoring and evaluation of radioactivity. (NSA of Japan)

43507 EFFECTS AND PROTECTION OF RADIATION FROM ATOMIC FACILITIES. 1. PRINCIPLES CONCERNING THE EFFECTS AND PROTECTION OF ATOMIC RADIATION ASSOCIATED WITH NUCLEAR POWER. Miyake, Yasuo (Tokyo Univ.). Genshiryoku Kogyo, 15: No. 3, 6-8(Mar. 1969). (In Japanese).

The health physics hazards of reactors and nuclear power

plants are presented with emphasis on radiation hazards in the handling of nuclear fuels, in the operation of the reactors, and in radioactive waste processing and disposal. It was concluded that, in Japan, more attention should be directed toward protecting personnel against these hazards. (TSS) (NSA of Japan)

43508 EFFECTS AND PROTECTION OF RADIATION FROM ATOMIC FACILITIES. 3. RELEASE OF RADIOACTIVE GASES FROM ATOMIC FACILITIES. Ito, Naotsugu (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 15: No. 3, 14-19(Mar. 1969). (In Japanese).

In considering the effects of released radioactive gases, a distinction must be drawn between normal operation and accidents involving atomic facilities. Depending on the conditions, different measures of radiation protection are taken. When radioactive gases are released into the atmosphere, the populace around the facility is necessarily subjected to both external and internal exposures. Pasquill's formula, assuming the Gaussian distribution of concentration in the air, is in good agreement with the experiment for radioactive gases from a stack. Charts derived from the formula are applicable in many cases of similar radioactive-gas release. When radioactive gas is dispersed into the atmosphere in radioactive clouds, it is easy to estimate internal exposures by inhalation from the downwind concentration. For the external exposure by beta rays, the dose rate is also proportional to the concentration; however, for gamma radiation, this is not the case. To estimate the deposition of radioactive materials on the ground, the formula by Chamberlain, incorporating the rate of deposition, is useful. The confirmation by experiments, in general, and the relation of radioactive-gas releases and the site conditions, are also described. (NSA of Japan)

43509 EFFECTS AND PROTECTION OF RADIATION FROM ATOMIC FACILITIES. 4. RADIATION PROTECTION FROM REACTORS. Katsurayama, Kosuke (Kyoto Univ.). Genshiryoku Kogyo, 15: No. 3, 23-8(Mar. 1969). (In Japanese).

The fundamental principles of radiation control and protection are described, and methods for eliminating problems of radiation protection during the design, construction, and operation of nuclear facilities are discussed. Measures necessary for ensuring protection against radioactivity in reactor coolants, effluents released to the atmosphere, etc., are considered. Finally, procedures necessary for controlling radioactivity during the normal operation of reactors and during radiation accidents are explained. (NSA of Japan)

Vacuum Engineering

Refer also to abstracts 43449 and 43624.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 43272, 43448, 43610, and 43763.

43510 (AD-685877) THE ELECTROSCOPE: A HOME-MADE RADIATION DETECTION INSTRUMENT FOR HOME USE. Callahan, Emerson Dower; Kaplan, Arthur L. (Technical Operations, Inc., Burlington, Mass.). May 15, 1960. Contract CDM-SR-59-33. 23p. (TO-B-60-21). CFSTI.

The results of an experimental research study to determine the feasibility of building an electroscope on a do-it-yourself basis from readily available materials, for use as a citizen's personal ratemeter, are presented. This radiation detection device can be built by practically anyone in an hour or two for a materials cost of less than a dollar and could serve both as a training instrument, and as an operational instrument. The useful operating range of the electroscope described is about 50 mr/hr to 5 r/hr, corresponding to instrument exposure times from about two minutes, down to three or four seconds. (auth) (USGRDR)

43511 (AD-685999) DIRECT METHOD OF DETERMINING THE SENSITIVITY OF MICROCRYSTALS TO CHARGE PARTICLES. Zhdanov, A. P.; Kuks, I. M. Translated from Usp. Nauch. Fotogr., 12: 49-52(1966). 13p. (FTD-MT-24-347-68). CFSTI.

A charged particle, braked in a solid, expends on the formation of an unbalanced pair of carriers the same amount of energy, regardless of its mass charge and velocity. Therefore, it is natural to determine the sensitivity of microcrystals of nuclear emulsions to any charged particles as the end-point energy of the electron, beginning with which the braking of the electron inside a microcrystal up to stopping will form a center of development in it. Finding this threshold portion of energy is possible, for example, by the photographic efficiency of the action of electrons of different energies on a monolayer preparation of an investigated emulsion. Irradiation was performed of the sequence of fields on one preparation, where the energy of electrons was increased from 100 to 800 eV, while the density of irradiation remained constant, 0.1 electron microcrystal. (USGRDR)

43512 (AD-687388) ALTERNATIVE RADEF LOGISTICAL SYSTEMS. Final Research Report. Norman, David A. (Stanford Research Inst., Menlo Park, Calif.). Mar. 1969. Contract DAHC20-68-C-0136. 108p. CFSTI.

The study developed operational requirements for the quantity, type, accuracy, and mission life of radiological instruments used in the nation's monitoring system. Five alternative logistical systems were postulated; four of the systems are based on the sudden attack activated concept and one system is based on the crisis activated concept. Instrument reliability, effectiveness, and maintenance is discussed. Cost effectiveness of the five systems postulated is presented. (USGRDR)

43513 (AD-687868) GAMMA DETECTING-INDICATING SYSTEM AN/GKQ-4. Sturman, Ivan (Tracerlab/West, Richmond, Calif.). Mar. 1969. Contract AF29(601)-5995. 68p. (AFWL-TR-68-97). CFSTI.

The AN/GKQ-4 consists of a set of devices for monitoring gamma radiation intensity from as many as 10 remote detectors located as far as 10 miles line-of-sight from a central control and readout station. Either of two modes of data transmission, radio or land line, may be used. A voice communication capability is available between the remote detectors and the central station. This is used during installation, checkout and maintenance. The present design and frequency allocation for the radio telemetry limit the distance of the remote stations to approximately 10 miles line-of-sight. Each remote detector consists of a rugged enclosure, ion chamber detector, control module, command receiver, telemetry transmitter, power supply, a rechargeable battery, and an antenna. (auth) (USGRDR)

43514 (CEA-R-3739) PHOTON FLUENCE MEASUREMENTS RELATIVE TO A BREMSSTRAHLUNG. Merle, Gerard; Zerbib, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1969. 34p. (In French). Dep. CFSTI (U. S. Sales Only).

With the help of a gamma spectrometry using a NaI(Tl) crystal, the relation of the pulse distributions received on a multichannel spectrometer to the spectral distribution of the photons is studied. Use was made of a previously calibrated gamma probe for measuring mono-energetic photon fluence. A simple method is used for producing the spectrum for an energy range from 30 keV to 2 MeV; the photon population is classified in about twenty groups. The determination of these groups, whose width increases with the energy E_γ, depends on the probe parameters and on the probability used for the calculation of the gaussian distribution of the pulses of the total absorption peak, centered on the group under consideration. The spectral analysis method is tested for one and then several radionuclides which are present simultaneously and whose gamma emission is known. The tests are complemented with fluence measurements with a view to testing the validity of the method proposed. The class determination operation (number and width) and the calculation of the spectral distribution of the photon fluences and of the irradiation intensities are carried out by computer (FORTRAN IV program). An actual example is described for measuring the bremsstrahlung near the 2-MeV Van de Graaff YVETTE at the Saclay Nuclear Sciences and Technology Institute (I.N.S.T.N.). (auth)

43515 (CONF-681063-, Paper 2.1) PORTABLE GAMMA MONITOR SGM 2300. Glavic, B.; Cotman, K.; Kelsin, D.; Borovsak, M. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). 2p. (In Solvenian).

The design and construction of the portable gamma monitor SGM 2300 is described. The instrument is completely transistorized and is made in the form of a pistol. An advantage of the instrument is that it has a logarithmic scale of the indicator. The e-monitor consists of a scintillator, a photomultiplier tube, a MOSFET differential stage is applied, used as an electronic voltmeter. The instrument is very useful in isotope laboratories of medical institutions. (auth)

43516 CONF-681063-, Paper 2.4) INSTRUMENTATION FOR MEASUREMENT AND ANALYSIS OF RADIATIVE SAMPLES. Muzdeka, Slobodan; Frantiovic, Predrag; Damljanovic, Dragolijub; Kovac, Bela (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 6p. (In Solvenian).

The instrument for the measurement of low-level beta-active samples is described, with the sensitivity of the order of 10^{-12} Ci. For gamma-activity measurement of solid and liquid samples an equipment is developed using linear integrated circuits and micrologic elements, which consists of a pulse amplifier, pulse-height analyzer, linear electronic time base, rate-meter and scaler. Gamma spectra of several radioactive elements are given, obtained with the described equipment, in order to illustrate its capabilities. Both scintillation and semiconductor detectors have been used. The equipments can be used both in laboratory and field conditions. (auth)

43517 (CONF-681063-, Paper 2.5) EQUIPMENT FOR GAMMA RADIATION EXPOSURE DOSE-RATE AND GAS ACTIVITY MEASUREMENTS. Muzdeka, Slobodan; Sobajic, Miodrag; Blagojevic, Ratomir (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 4p. (In Slovenian).

A very sensitive instrument is described for the measurement of gamma exposure rate at the level of natural background. Two ion chambers of 2 × 12 l volume are applied as radiation detectors. The measuring ranges are: 10 μR/h, 1 mR/h and 10 mR/h. The instrument is applicable also for the measurement of low-level gas activity. For the measurement of higher exposure dose-rates a portable transistorized instrument is developed, having four linear measuring ranges (from 10 mR/h to 10 R/h). (auth)

43518 (CSIR-283) THE MANUFACTURE OF Ge(Li) DETECTORS. de Jesus, A. S. M. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). 1969. 15p. Dep. CFSTI (U. S. Sales Only).

Ge(Li) detectors have been manufactured at the National Physical Research Laboratory using both the planar and coaxial configurations. The manufacturing procedure and characteristics of the detectors are given. Problems associated with the base material and other problems encountered during the various phases of manufacture are discussed. The elimination of the need for a reetch when transferring a detector from one cryostat to another is also described. (auth)

43519 (LA-4168) RESPONSE OF ALPHA SURVEY MONITORING INSTRUMENTS VS DISTANCE FROM THE SOURCE. Craig, Harry W. (Los Alamos Scientific Lab., N. Mex.). Apr. 24, 1969. Contract W-7405-eng-36. 5p. Dep. CFSTI.

The response of five types of alpha survey instruments used at the Los Alamos Scientific Laboratory was evaluated relative to the source distance from the meter probe. Measurements were made using a 1-in.-diam source as well as a source with an area

the same size as the sensitive area of the instrument probe. The use and limitation of each instrument are discussed. (auth)

43520 COUNTING EFFICIENCY DEPENDENCY ON TEMPERATURE OF ^{3}H- AND ^{14}C-SAMPLES IN LIQUID SCINTILLATORS. Kaczmarczyk, N.; Ruge, I. (Technische Hochschule, Munich). Int. J. Appl. Radiat. Isotop., 20: 653-69(Sept. 1969). (In German).

The pulse height spectrum of tritium and radiocarbon is shifted to smaller pulse heights with rising temperature, similar to the spectrum-shift as a result of increasing quenching. Consequently the counting efficiency of ^{3}H- and ^{14}C-samples in liquid scintillators increases approximately linearly with falling temperature in the range between +23°C and −25°C. The percentage of increase in the counting efficiency as a result of sample-cooling is greater when the quencher concentration increases and when the gain and the energy of the radioisotope decrease. The counting efficiency reacts to variation of temperature more as the total volume of the sample and the scintillator solution deviates from 7.5 ml. The following conclusions are derived from the temperature response of the counting efficiency; when the temperature decreases the balance-point and the calibration curve for the external standardization are shifted, the background rises slightly compared with the value at +6°C, the statistical goodness for samples of high counting rate increases linearly, and for samples of extremely small counting rate increases more powerfully. (auth) (UK)

43521 A 4π PLASTIFLUOR BODY COUNTER FOR CLINICAL USE: CALIBRATION. Delwaide, P. A. (Univ., Liege). Int. J. Appl. Radiat. Isotop., 20: 623-39(Sept. 1969).

The whole-body counter described consists of a plastifluor detector of approximate 4π geometry, 18 photomultipliers, and a 3-channel spectrometer. Its principal technical characteristics are described, particularly resolution, which is of the order of the resolution provided by other organic detectors, and efficiency, which exceeds 50% for 1 MeV γ radiation. Efficiency is linear throughout a wide range of activities. For measurements of body ^{40}K and ^{137}Cs interference due to the relatively low discrimination requires the use of an indirect method of calibration based on algebraic manipulation of the values obtained. Under these conditions, a counting time of 200 sec yields body potassium values that are accurate and reproducible to within 5%. Initial values obtained by measurement of 500 normal subjects are in agreement with findings reported in the literature. (auth) (UK)

43522 CALCULATION OF THE RADIATION BALANCE OF THE MULTI-WIRE PROPORTIONAL COUNTER. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). pp 112-17 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

Methods are presented for calculating corrections for absorption of x radiation in multiwire proportional counters when the x-ray relaxation length is not small compared to counter diameter. Exact integrals are presented for the calculation of the fractions of x radiation which escapes the central counter, x radiation absorbed in the anticoincidence counters, and x radiation absorbed in the central counter. (J.W.R.)

43523 ATTENUATION OF PROPORTIONAL COUNTER PULSED BY EQUAL INTEGRATING AND DIFFERENTIATING TIME CONSTANTS. Mathieson, E.; Charles, M. W. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods, 72: 155-6(1969).

The attenuation of a proportional counter pulse having the form $C \log (1 + t/t_0)$ by a shaping network consisting of equal integrating and differentiating time constants has been computed numerically. The results of these calculations, which can be presented on a single curve or summarized in a simple linear relationship, may be used with relevant experimental data to estimate gas gain or to predict pulse heights from a particular system. (auth)

43524 ATTENUATION OF PROPORTIONAL COUNTER PULSES BY EQUAL INTEGRATING AND DIFFERENTIATING TIME CONSTANTS. Gott, R.; Charles, M. W. (Univ. of Leicester, Eng.). Nucl. Instrum. Methods, 72: 157-60(1969).

Mathieson and Charles theoretical calculation of the attenuation of counter pulses in a shaping network having equal integrating and differentiating time constants has been verified over the typical operating region of a proportional counter. The results enable the effective positive ion mobilities to be evaluated for several gases and these values have been used to indicate a method for optimization of rise time discrimination systems used in x-ray astronomy. (auth)

43525 POLYETHYLENE MODERATED ^{3}He NEUTRON DETECTORS. East, L. V.; Walton, R. B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods, 72: 161-6(1969).

Two high-efficiency neutron detectors which consist of arrays of ^{3}He proportional counters imbedded in polyethylene moderators were investigated. One of these, a modified "long counter" containing five ^{3}He counters, has an intrinsic efficiency of (11.5 ± 0.5)% over the neutron energy range from 25 keV to ≳4 MeV. The second detector contains thirteen ^{3}He proportional counters imbedded in two large-area (3100 cm²) polyethylene slabs which are positioned in tandem. By appropriately arranging the counter slabs and sheets of neutron absorbing and moderating materials, the slab detector may be operated either as a flat-response detector with an intrinsic efficiency of ≈18% or in an "energy-discrimination" configuration to provide coarse neutron energy-spectrum information. (auth)

43526 INTEGRATED E AND dE/dx SEMICONDUCTOR PARTICLE DETECTORS MADE BY ION IMPLANTATION. Martin, F. W. (Ion Physics Corp., Burlington, Mass.). Nucl. Instrum. Methods, 72: 223-5(1969).

Detectors with two p–n junctions in one piece of silicon are described, having typical sensitive regions of width 9 and 1400 μm beginning 0.5 and 17 μm below the surface. (auth)

43527 PROBLEMS IN THE APPLICATION OF CHANNEL-PROPORTION METHOD FOR THE CORRECTION OF QUENCHING EFFECT DURING THE ACTIVITY MEASUREMENT OF TRITIUM-LABELLED SAMPLES BY LIQUID-SCINTILLATION. Szarvas, T.; Oemboely, Cs.; Vegh, G. (MTA Izotop Intezet Szerveskemiai Osztalya, Budapest). Atomtech. Tajek., 11: 585-94(Nov. 1968). (In Hungarian).

The channel-proportion method for the analysis of tritium-labeled samples is described, which — with the help of regularly controlled standard efficiency/channel-proportion curve — provides the same accuracy as the internal standard method. Its use is especially advantageous for serial analyses, whereas for samples of low activity the values obtained by the internal standard method are more reliable. (auth)

43528 A STUDY OF THE PROPERTIES OF AN IONIZATION SPECTROMETER WITH 10, 20.5, AND 28 GeV/c INCIDENT PROTONS. Jones, W. V. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger. Institut fuer Extraterrestrische Physik, Garching, Ger.); Pinkau, K.; Pollvogt, U.; Schmidt, W. K. H.; Huggett, R. W. Nucl. Instrum. Methods, 72: 173-87(1969).

Results of calibration measurements of an ionization spectrometer with 10, 20.5 and 28 GeV/c protons are presented. An ionization spectrometer has been employed in several successful balloon flights in combination with spark chambers and different target materials to study high energy cosmic rays. A brief description of the apparatus is given along with details of the balloon flights as well as the exposures at the Brookhaven AGS. The calibration measurements show that it is possible to measure the energy of high energy particles with an ionization spectrometer which is only three interaction lengths deep. A linear dependence has been found to exist between the primary energy and the mean of the measured ionization loss, as well as between primary energy and the mean of the maximum of the measured ionization loss for particles whose first interaction was in the spectrometer. However, this linear relationship does not hold for particles which undergo their first interaction in a target above the spectrometer. For incident protons which interact in the top layer of the spectrometer, the accuracy of the energy determination is +60% and −30%; +50% and −30%; +50% and −25%; at 10, 20.5 and 28 GeV/c, respectively. An attempt has been made to simulate alpha-particle interactions in the spectrometer by using combinations of separate proton events. It is shown that the accuracy of the energy determination for these simulated alpha particles is +50% and −28%; +44% and −26%; +44% and −25%; respectively, for kinetic energies of 9, 19.5 and 27 GeV/nucleon. (auth)

43529 ARMSPAN: ARGONNE MULTICHANNEL STORED PROGRAM ANALYZER. Lenkszus, F. R.; Strauss, M. G. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 72: 188-94(1969).

A pulse height analysis system based on a computer (DDP-116) with a memory of 4096 16-bit words has been developed. While the cost of the system is comparable to that of a conventional multichannel analyzer, its capabilities are far greater. The system features include single or 2-parameter pulse height analysis, software controlled servo-stabilization of gain and zero-intercept, digital bias, flicker-free interlaced display, etc. The deadtime of the system is comparable to that of a conventional multichannel analyzer. Data are stored in 3000 memory locations and programs in the remainder. Basic functions such as ACCUMULATE, DISPLAY and READOUT are controlled by special front panel sense switches. Communication between operator and computer is in decimal. Data reduction programs include routines for de-

terminations of centroids, fwhm and peak/total. Energies corresponding to unknown spectral peaks are computed by using the system's differential response to correct for non-linearity. Prompt calculations on the accumulated data provide the researcher with key parameters which enable him to determine whether the data are meaningful and he should proceed, or the run should be repeated. Similar calculations at a later time may result in inefficient use of time and experimental facilities. (auth)

43530 ON THE PERFORMANCE OF HELIUM SCINTILLATION COUNTERS. Guazzoni, P.; Pignanelli, M. (Univ., Milan. Istituto Nazionale Fisica Nucleare, Milan). Nucl. Instrum. Methods, 72: 195-200(1969).

A systematic study of the mechanism of helium scintillation counters is reported. The decay time and light yield in scintillations produced by α particles in pure helium or helium containing other gases, at low concentrations, was measured. Some mixtures, as (He-CO_2) and (He-N_2-NO) can have practical interest. The factors determining the energy resolution are discussed. (auth)

43531 GRAPHICAL ANALYSIS OF NEUTRON LINE SPECTRA. Nisle, R. G. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods, 72: 205-9(1969).

A graphical method of analysis has been used successfully to reduce recoil-proton counter data to a neutron spectrum from a proton spectrum of discrete sources. A computer generated synthetic curve is matched visually on a cathode ray oscilloscope display to the experimental curve and the parameters of the computer curve are taken to be those of the experimental curve when a match is obtained. The parameters used are source energy and intensity, and instrument resolution. The instrument response to a monoenergetic source is assumed to be Gaussian and the source width is assumed to be negligible compared with the instrument resolution. The source intensity, measured in this way, corresponds to the area used in area analysis methods for evaluating the results of cross-section measurements. (auth)

43532 THRESHOLD OSCILLATIONS IN BROMINE-QUENCHED G-M COUNTERS. Usacev, S.; Seman, M. (Comenius Univ., Bratislava). Nucl. Instrum. Methods, 73: 41-4(1969).

The influence of admixture of bromine in the neon gas filling of the counter on the discharge mechanism and the threshold oscillations origin is discussed. The theory of threshold oscillations origin is experimentally verified by measuring the maximum time of metastable neon atoms existence in the counter and by determining the counter dead time in the region of threshold voltages. The counter dead time is found to be shorter than the maximum time of metastable neon atoms existence in the counter; thus it seems possible to explain the threshold oscillation origin by slow build-up of the discharge. The filling apparatus and the electronics employed in the measurements are described. The figures of pulse forms at the threshold voltages are also presented. (auth)

43533 WALL-LESS PROPORTIONAL COUNTER HODOSCOPE WITH A COMPUTER ON-LINE. Eiben, B.; Faissner, H.; Holder, M.; Koenig, J.; Krison, K.; Umbach, H. Technische Hochschule, Aachen). Nucl. Instrum. Methods, 73: 83-8(1969).

A proportional counter hodoscope was constructed, with the walls consisting of a few parallel wires only. The apparatus is operated with a PDP-8 computer on-line. It is being used in a search for fractionally charged particles in cosmic ray air showers. (auth)

43534 SIMPLE VERSATILE CRYOSTAT FOR ENCAPSULATED DETECTORS. Turcotte, R. E.; Moore, R. B. (McGill Univ., Montreal). Nucl. Instrum. Methods, 72: 210-12(1969).

A simple, inexpensive and versatile cryostat for encapsulated detectors is described. The cryostat operates at liquid nitrogen temperatures with molecular sieve pumping. Standard performance was: pressure less than 5×10^{-5} mm, temperature of detector less than 80°K, consumption of liquid nitrogen about 1 liter per day. (auth)

43535 AN ASSOCIATED GAMMA RAY TIME-OF-FLIGHT SPECTROMETER FOR THE MEASUREMENT OF FAST NEUTRON-GAMMA RAY ANGULAR CORRELATIONS. Joy, T. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods, 73: 240-52(1969).

In order to study (n,γ) angular correlations following deuteron stripping reactions, an associated gamma ray time-of-flight spectrometer has been developed using a multi-parameter analysis system based on an on-line computer. The system includes a facility for digital correction of time-walk. (auth)

43536 SHORT SHAPING OF SLOWLY RISING PULSES, WITH INTEGRATED POLE CANCELLATION. Chaminade, R.; Pain, J.; Cros, M. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods, 73: 122-4(1969).

Slowly rising input pulses keep, after short shaping, a slow tail decaying as the input pulse rise time. By partial differentiation this tail can be reduced to the short value which would be obtained from faster input pulses; this method works as well with single or double delay line clipped pulses. (auth)

43537 DESIGN OF AN ION SELECTOR FOR ION IMPLANTATION IN SEMICONDUCTORS. Stanchi, L. (EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 73: 313-22(1969).

The purposes animating the design of a magnet for use as ion analyzer are described. The magnet is used for selecting ions to be implanted in semiconductors. The conditions to be satisfied for double focalization instead of the more common single focalization are illustrated. Simple equations are derived and computed for very low currents. Effects of space charge led to a nonlinear equation which has been evaluated by means of a digital computer. The final result is a magnet having hyperbolic pole shoes and an aperture of 127°. (auth)

43538 DIGITAL AUTOMATIC POSITIONING SYSTEM. Davis, J. F.; Huang, W. F.; Burton, L. D. (Univ. of Louisville, Ky.). Nucl. Instrum. Methods, 73: 333-5(1969).

A flexible and reliable positioning system for automatic control of experiments is described. Its main components are a stepper motor and two electro-mechanical counters. The system is used primarily for angular correlation measurements. Data acquisition, detector positioning, instrument resetting, etc., are fully automatic. With little modification the system is readily adaptable to many other applications. (auth)

43539 A SEMI-EMPIRICAL EFFICIENCY EQUATION FOR Ge(Li) DETECTORS. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Regina, Can.). Nucl. Instrum. Methods, 73: 210-14(1969).

A semi-empirical equation to describe the relative photopeak efficiency of Ge(Li) detectors (of various sizes and shapes) in the gamma-ray energy range of 200 to 1500 keV is presented. The relative efficiency of a detector may be calculated from $\epsilon = k[1 - \exp(-\tau V^{\frac{1}{3}}) + 0.012V\sigma \exp(-0.8E)]$, where τ and σ are the respective photoelectric and Compton absorption coefficients of germanium, V is the active volume of the detector, E is the gamma-ray energy and k is the constant relating the absolute to the relative efficiency. Absolute ϵ/k values, calculated from the proposed equation are in agreement with experimental values for detectors of small sizes. In large size detectors a discrepancy is observed between the calculated and experimental ϵ/k values. A possible explanation for this discrepancy is given on simple geometrical grounds. (auth)

43540 SENSITIVITY STABILIZATION OF SOLID-STATE AVALANCHE COUNTER. Feulner, W. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 73: 215-19(1969). (In German).

A control system is described for use with a semiconductor avalanche detector. The detector is an alloyed silicon diode operated in breakdown. For constant radiation sensitivity the temperature dependence of the supply voltage and that of the breakdown voltage must coincide. This is achieved by a novel method. The detector delivers pulses of statistically variable duration and the expectation value of the pulse duration is a measure of the radiation sensitivity. Each detector pulse is compared with a pulse of fixed duration. The differential signals are summed in an integrator to form the supply voltage for the detector. It is shown that this system is capable of compensating for all temperature changes after a predictable transient period. (auth)

43541 SMALL GERMANIUM DETECTOR WITH NEAR PERFECT COLLECTION. Gibbons, P. E.; Howes, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 73: 221-2(1969).

The performance of a small germanium detector is described. The quality of charge collection is near perfect and some correlation with lifetime measurement is obtained. (auth)

43542 A POSITION SENSITIVE NEUTRON DETECTOR. Berkowitz, E. H. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nucl. Instrum. Methods, 73: 225-7(1969).

The position response of a position sensitive scintillation neutron detector is described. (auth)

43543 LIGHT FLASHES EMITTED FROM DIODES FOR SIMULATION OF SIGNALS FROM SCINTILLATORS FOR TEST-

ING AND CONTROL OF DETECTION SYSTEMS. Bernaudin, Ph.; Bosshard, R.; Zajde, C. (Ecole Normale Superieure, Orsay, France). Nucl. Instrum. Methods, 73: 157-66(1969). (In French).

The light flash of fast emitting Ga AsP diodes operated in forward conduction at room temperature has been investigated for simulation of scintillator detectors. The 6500 Å photons can be detected by an S11 photocathode and a good simulation in pulse shape and in timing can easily be obtained. It is shown that for good simulation of scintillator detectors, exponential decaying pulse should be used to drive the diode. The jitter in timing is less than 2 ns when the light increases by a factor 10. It can be reduced to 0.5 ns by applying a 1 V forward bias to the diode. Temperature stability is good, better than −0.5%/°C; the diodes may hence be used for calibration without difficulty. An experimental arrangement used with a ladder-counter at the Linear Accelerator at Orsay is described and practical details are given. (auth)

43544 ON THE COMPOSITION OF THE COUNTING-LOSS CORRECTION FORMULA IN NUCLEAR PARTICLE DETECTION EXPERIMENTS. Pacilio, N. (CSN, Rome). Nucl. Instrum. Methods, 73: 167-72(1969).

A detailed analysis is given of how a distribution of random events, e.g., nuclear particles out from a constantly emitting source, is distorted by the measuring apparatus. The different correlations introduced by a counting chain and by a distribution analyzer are separately described. A number of counting-loss correction formulae are used for restoring the original true distribution of events and discriminating the bias introduced by the instrumentation. An extensive range of experiments has been conducted in order to focalize the main points of the matter and to find out the most suitable formulae for correcting the raw data and determining the two components of the measuring apparatus dead-time. (auth)

43545 STUDY OF THE FOCUSING PROPERTIES OF A DETECTOR FOR SLOW IONS. Brouillard, F.; Godart, O. (Univ., Louvain, Belg.). Nucl. Instrum. Methods, 74: 141-6 (1969).

The characteristics are studied of an ion detector based on the production of secondary electrons on a high tension electrode, followed by detection in a phosphor. The trajectories of the secondary electrons have been calculated and figures are presented, which are useful to determine the location, the size and the shape of the phosphor, that ensure complete collection from a given area on the electrode. Data related to the counting efficiency are also presented. (auth)

43546 NEW TECHNIQUE FOR NUCLEAR EMULSION STUDIES: INCLINED STAGES. Hebert, J.; Mes, H.; Molloy, H. R.; Vincent, M.-A. (Univ., Ottawa). Nucl. Instrum. Methods, 74: 39-41(1969).

A microscope stage has been designed to facilitate the scanning of nuclear emulsions. The technique is based on the use of a scanning beam of light oblique to the direction of motion of the stage, permitting the whole depth of the emulsion to be viewed in a single field. The time required for scanning in a given area is reduced by a factor of two to three, compared with the standard area scanning technique, without appreciable loss of efficiency. A second stage, composed of a standard low-noise stage with an upper, rotating stage of variable tilt, is also described. The use of this compound stage greatly facilitates the analysis of events with steep tracks. (auth)

43547 PULSE DIVIDER FOR USE WITH POSITION SENSITIVE DETECTORS. Doehring, A.; Kalbitzer, S.; Melzer, W.; Stumpfl, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 74: 42-4(1969).

A simple pulse divider has been developed for use with high resolution position sensitive detectors. The divider mainly consists of two elements, a log function generator and a sampling amplifier. The division is carried out with a precision of 1% of full scale over a pulse height range of 40 : 1 for the position signal and 16 : 1 for the energy signal. Results are given for the use of the divider with an ion implanted position sensitive detector. (auth)

43548 DESIGN OF A NEUTRON SCATTERING CHAMBER USING MONTE CARLO CALCULATIONS. Goellnitz, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Heidbreder, E.; Pinkau, K.; Reppin, C.; Schoenfelder, V.; Gorenflo, R. Nucl. Instrum. Methods, 74: 109-22(1969).

A spark-chamber-experiment for the measurement of solar and atmospheric neutrons in the energy-range from 50–150 MeV is described. The principle of measurement is the double elastic scattering process of the incoming neutrons with hydrogen atoms. The experimental realization of this process is difficult due to the small probability of occurrence of two elastic scattering processes. In order to optimize the instrument, extensive Monte Carlo studies of various types of scattering chambers have been performed, and these calculations and the results are described here. As a result of these studies, an efficiency of 1.2×10^{-3} has been obtained for double elastic scattering events of 100 MeV neutrons for an optimized design of the chamber. (auth)

43549 COLLIMATED DETECTOR RESPONSE TO POINT, LINE, AND PLANE SOURCES. Steyn, J. J. (NUS Corp., Rockville, Md.); Andrews, D. G.; Dixmier, M. Nucl. Instrum. Methods, 74: 123-31(1969).

Analytic relationships for determining the geometrical response of a collimated detector to point, line, and plane radiation sources are given. The formulas consider right-cylindrical and conical collimators and angular orientation of the source plane. A comparison of theory with experiment is given. (auth)

43550 STUDY OF ELECTRON RESPONSE OF Si-SURFACE BARRIER DETECTOR WITH MAGNETIC SECTOR FIELD SPECTROMETERS. I. THE SECTOR FIELD SPECTROMETER. Haeusler, B. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Instrum. Methods, 74: 86-92(1969). (In German).

This first part describes the calculation and design of a symmetric, double focusing 75° sector field spectrometer which is used for response measurements of solid state detectors given in part 2. The design feature was derived from the use as a versatile laboratory instrument for generating a monochromatic parallel beam of electrons of energies up to 3 MeV. The specific data of the instrument are: radius of curvature−ρ = 6.62 cm, distance effective-field-boundary to radioactive source−l = 17.25 cm, resolution−$\Delta p/p$ = 1.5%, solid angle−Ω = 0.1%, and pole-piece gap−k = 2.0 cm. (auth)

43551 OVERLAPPING SCINTILLATOR DETECTION SYSTEM FOR ELECTRON SCATTERING. Huberts, P. K. A, De Witt; De Vries, H.; Van Niftrik, G. J. C.; Peterson, G. A. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods, 74: 27-32(1969).

A high-resolution system for detecting high-energy electrons in the focal plane of a magnetic spectrometer is described. It consists of 10 overlapping scintillators which form 19 detection channels and a Cherenkov counter. The results obtained on logic circuitry are interpreted and processed by a small on-line computer. The total detection efficiency is independent of electron energy and the momentum resolution per channel is 0.1%. Construction and performance are described. (auth)

43552 RADIATION DETECTOR AND RECORDER (Mar. 4, 1969) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1905).

5 drawings.

This sentinel-type detector, which is covered by U. S Patent 3,431,414, provides time-stamped records of exposures to rapid pulses of x and γ radiation. The detector consists of a CsI(Tl) scintillator, photographic film, Hg microcoulometer, and a time-reference scale housed in a light-tight enclosure. Visible light generated in the scintillator is transmitted to the film through the time-reference scale and the transparent gap of the electrolyte in the microcoulometer. The image of the time reference scale and the gap formed on the film shows the time at which the irradiation pulse occurred. Response is satisfactory in dose ranges of ~0.2 to ~50 mr in intervals from several nanoseconds to several minutes. Timing can be adjusted from a few hrs to several months. Exposure records can be read with uncertainties of ±0.1% of the full-scale timing interval. The detector is used around high-voltage accelerators and x-ray machines. (For details see TID-4100) (See also 23: 16108) (F.S.)

43553 CONTINUOUS BLOOD MONITORING OF HARD BETA-EMITTING ISOTOPES IN SMALL LABORATORY ANIMALS. Roba, J.; Roncucci, R.; Lambelin, G. (Continental Pharma, Machelen, Belgium). Anal. Lett., 2: 325-32(June 1969).

A monitoring system for recording very fast variations in blood levels of ^{32}P-labeled compounds is described. The flow-cell used is suitable for continuous determinations in anesthetized small laboratory animals (e.g., rats). The technique reported has been developed for hard beta-emitting isotopes. However, changing the counting unit, the described flow-cell can be adapted for gamma-emitting isotopes. With our system, efficiencies of the order of 40% have been obtained for ^{32}P in whole blood. (auth)

43554 DEPOLARIZATION EFFECTS OF DETECTOR SIZES IN GAMMA-RAY POLARIZATION MEASUREMENTS. Raju, A. Sanyasi; Lakshminarayana, V. (Andhra Univ., Waltair, India). Curr. Sci. (India), 38: 407(Sept 5, 1969).

A study of the polarization effects in incoherent scattering of gamma rays is presented. Three thallium-activated sodium iodide scintillation detectors connected in two sum-coincidence arrangements were used for the measurements. Measured data are compared to uncorrected Klein–Nishina values and Klein–Nishina values corrected for finite size effects. The results indicate that the depolarization effects of the detectors used are negligible for the determination of asymmetry ratios. (W.H.K.)

43555 ORIGIN OF COUNTING STATISTICS IN SIMPLE NUCLEONIC INSTRUMENTS. Joyce, W. B. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Amer. J. Phys., 37: 489-94 (May 1969).

The variance of the (Poisson) counting statistics of a typical nucleonic instrument is shown to be expressible as the sum of contributions from a variety of distinct random processes. The utility of this decomposition is illustrated in an example where the effect of the random decay rate of the isotope is removed. Contradicting numerous articles and texts, it is also shown that the random decay rate of the isotope and the random detector counting statistics do not participate in a cause–effect relationship, but are nearly independent phenomena in most instruments. (auth)

43556 DETECTING RADIATION WITH A SUPERCOOLED LIQUID. Varshneya, N. C. (Roorkee Univ., India). Nature (London), 223: 826-7(Aug. 23, 1969).

If a supercooled liquid is exposed to ionizing radiation the probability of its homogeneous freezing increases, and explanations for this are briefly discussed. It was proposed to make use of this effect in a technique for detecting high energy ionizing radiation, the liquid being supercooled to a temperature at which the ionizing radiation could be detected by tracks of ice crystals formed along its path. Experiments were carried out using triple-distilled, suspension-free water as the medium, contained in a glass or Perspex vessel, and cooled to −6 C. Cosmic ray tracks were observed. Photographs of the cosmic ray tracks and some tracks from ^{60}Co γ-rays are included. (UK)

43557 PROPERTIES AND POSSIBILITY OF THE USE OF THE LIQUID DIELECTRIC IONIZATION CHAMBER. Chorvat, Dusan (Research Inst. of Industrial Hygiene and Occupational Diseases, Bratislava); Bartok, Jan; Saro, Stefan. Jad. Energ., 15: 275-7(Aug. 1969). (In Czech).

The basic problems of the liquid dielectric ionization chamber design are discussed. The manners of use of such type of ionization chambers are briefly mentioned. The basic parameters of designed ionization chamber are presented. As a calibration source the ^{60}Co was used with the activity of 100 mCi. (auth)

43558 LUMINESCENCE AND SENSITIVITY OF NUCLEAR PHOTOEMULSIONS AT LOW TEMPERATURES. Kartuzhanskii, A. L.; Belous, V. M.; Matvienko, V. I.; Shur, L. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 130-4(Feb. 1969).

Translated from Opt. Spektrosk., 26: 244-51(Feb. 1969).

The effect of different materials, principally optical sensitizers, on the temperature coefficient of sensitivity of nuclear emulsions at low temperatures was investigated. The influence of these materials on the nature of the quenching of the luminescence of an emulsion film in the green luminescence band was also studied. It was found possible to use quenchers of the luminescence of the silver halide in the capacity of sensitizers of nuclear emulsions at low temperatures. (auth)

43559 QUANTITATIVE β-RAY AUTORADIOGRAPHY IN THE PRESENCE OF LATENT IMAGE FADING. Friedlaender, J. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 437-46(1969).

Quantitative autoradiographic measurements are found to be possible even on an emulsion strongly affected by fading and when the exposure is carried out over a long time period. It is shown that under such circumstances the fading may be quantitatively described by two parameters: the mean life time τ of the latent image and a second parameter α which takes into account the variation of τ with the initial photographic density D. Both parameters depend upon the type of emulsion used. (auth)

43560 GAMMA RESPONSE OF SEMI-INSULATING MATERIAL IN THE PRESENCE OF TRAPPING AND DETRAPPING. Akutagawa, W.; Zanio, K. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 40: 3838-54(Aug. 1969).

The photoelectric and Compton response to γ rays for a detector made from semi-insulating material (i.e., a monocrystalline semiconductor containing trapping centers) was calculated for the case of charge transport by one type of carrier (electron or hole), and also for the case of two-carrier transport (electron and hole) with each carrier having the same mean free path. Approximate expressions were then derived for the observable γ-ray efficiency of the detector as a function of material parameters for CdTe crystals used in the fabrication of surface barrier detectors; this efficiency is dependent upon temperature and electric field intensity for specified values of the carrier mobility-trapping time product and the threshold used in the recording of spectra. Spectra and values for efficiency were determined at room temperature for γ rays at energy values from 0.393 to 1.33 MeV, and also as a function of temperature over the range 24° to 68°C for γ rays from a ^{60}Co source. The observations show behavior corresponding to a trap-limited response, and the presence of charge detrapping. (auth)

43561 PARTICLE DETECTION BY MEANS OF GAS DISCHARGE. Charpak, G. (CERN, Geneva). J. Phys. (Paris), 30: Colloq. C2, 86-96(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

This paper discusses some of the most recently developed detectors designed for gas discharge analysis. Particular emphasis is placed on the proportional wire chambers which offer many novel attractive features. (auth)

43562 ASSOCIATION OF DETECTORS IN NUCLEAR PHYSICS. Riou, M. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 30: Colloq. C2, 78-9(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The principles governing the association of detectors in nuclear physics are briefly investigated: especially, identification and separation of nuclei produced in a nuclear reaction, the precise measurement of their energy in one or two channel experiments. (auth)

43563 SEMICONDUCTOR DETECTORS. Coche, A. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 30: Colloq. C2, 64-9(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The main applications of semiconductor particle detectors are described. Particular emphasis is given to detection and spectrometry of heavy particles, and γ rays using Ge(Li) diodes. Among other characteristic properties of these counters, energy resolution, efficiency and time resolution are considered in more detail. A final discussion is devoted to the possible evolution of semiconductor detectors. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 44854 and 44893.

43564 (BLG-428) SOME USEFUL DATA FOR ^{6}Li SEMICONDUCTOR SANDWICH SPECTROMETERS. De Leeuw-Gierts, G.; De Leeuw, S. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). May 1968. 67p. Dep. CFSTI (U. S. Sales Only).

Reaction kinematics are discussed and some useful formulas derived. Spectrometer resolution as well for sum coincidence work as for triton spectrometry. Theoretical calculations are made under the fundamental hypotheses of an isotropic neutron flux distribution and numerical examples are worked out using a simple range-energy relation. Good qualitative agreement with experimental data is observed but difficulties arise for a quantitative comparison. This can to a certain extent be explained by the approximations made and errors on the range data used but the major difficulties arise from target inhomogeneities. Geometrical efficiencies are calculated for two practical spectrometer designs, i.e., the 2 π sandwich and the energy independent collimation. The latter is of particular interest in that the efficiency is a constant for a given spectrometer design and no corrections are necessary if there is no need for absolute flux measurements. For both calculations an isotropic neutron flux or, a beam perpendicular to the target surface and an isotropic emission of the secondary particles, are assumed. (auth)

43565 (CEA-CONF-1243) TREATMENT OF INFORMATION IN GAMMA SPECTROMETRY. Boulanger, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1967]. 45p. (In French). (CONF-680642-2). Dep.

From International Conference on Electronics and Automation, Herceg Novi, Yugoslavia.

A least squares method was developed for the analysis of total absorption peaks. The decomposition of a complex spectrum by the least squares method is given and it is shown that the derivative correction improves the precision very sharply. In the calculation, spectra of any energy were generated artificially beginning with a

library of simple spectra taken under the same experimental conditions. The principle of the generation is described. The use of a biparametric analysis chain made it possible to define the decay schemes by measuring the coincidence probabilities between the various transitions. These methods for the processing of information from a spectrometer were applied to a study of the decay scheme of ^{110m}Ag. (J.S.R.)

43566 (ORNL-tr-2193) INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES. REPORT OF RESEARCH GROUP ASSIGNED TO ALPHA ENERGY STANDARDS. Rytz, A. (Bureau International des Poids et Mesures, Sevres (France)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report. 10p. Dep. CFSTI.

Design modifications to the absolute alpha-particle spectrometer of the International Bureau of Weights and Measures for standardization of alpha sources are briefly discussed. (W.H.K.)

43567 (RT/EL-(68)12) AUTOMATIC CONTROL OF A POLARIZED NEUTRON SPECTROMETER. Babiloni, L.; Ricci, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 14p. (In Italian). (CONF-671081-1). Dep.

From 1st Conference on ANIPLA, Rome, Italy.

The increased power of the TRIGA reactor and the increased volume of data connected with the more complex experiments using the polarized neutron spectrometer have led to the study of the automation of the experiments themselves. An examination was made of the possible automatic measurement programs and of the most efficient organization of an electronic system to realize such a program. The results of these studies are reported. The new characteristics of the spectrometer are given. The measurement program selected and the logical organization of the automatic system are described. (tr-auth)

43568 DIRECTIONAL CORRELATION INVOLVED IN L-CAPTURE. Pool, M. L.; Measel, P. R.; Brannan, J. R. (Ohio State Univ., Columbus). pp 108-11 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

A fast coincidence system employing lithium-drifted solid state detectors was designed for measuring directional correlations in electron capture. Directional correlations were measured between the K and L x rays and conversion electrons and γ rays of ^{139}Ce. (J.W.R.)

43569 USAGE OF SOLID SOURCES FOR MEASUREMENT OF ELECTRON CAPTURE RATIOS. Palathingal, J. C. (Univ. of Michigan, Ann Arbor). pp 118-22 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

Measurement of intensities of atomic X-rays using proportional counters has been the standard method of determining ratios of electron capture from atomic shells of low binding energy. Gaseous sources are employed in these experiments. The necessity of using gaseous sources is a serious disadvantage of this technique. If a monatomic or submonatomic layer source, evaporated onto a low atomic number material is used inside a proportional counter, the intensity measurements can still be made with accuracy. The mean depth of penetration of the X-rays into the backing material is much larger than the range of the photoelectrons or Auger electrons produced by the X-rays. When the backing material is suitably chosen, the secondary X-rays emitted in these processes may also be ignored. For these reasons, the shape of the spectrum of X-radiation due to electron capture will not be substantially altered by the presence of the backing material. (auth)

43570 PHOTOPEAK METHOD FOR THE COMPUTER ANALYSIS OF GAMMA-RAY SPECTRA FROM SEMICONDUCTOR DETECTORS. Routti, J. T.; Prussin, S. G. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 72: 125-42(1969).

A method is presented for computer analysis of γ-ray spectra from semi-conductor detector systems. A mathematical formalism for the representation of photopeaks and the continua in their vicinity which is applicable to analysis of spectra measured under widely varying conditions is presented. With this formalism the line shape is defined for each peak in the spectrum. The region of data about a single peak or multiple peaks is then fitted with the shape functions and a function representing the background continuum. The line-shape calculations and the fitting are performed by using a least-squares procedure with an iterative gradient minimization method with variable metric. For an automatic analysis an algorithm is developed to search the raw data for statistically significant peaks. The method has been incorporated into a general-purpose Fortran computer program. In addition to searching and fitting single and multiple peaks, the code performs the energy, efficiency, and line-shape calibrations and makes complete statistical and calibration-error estimates. For establishing the goodness of fit for each peak the output also includes numerical and graphical representation of the fit. Optionally, an on-line cathode-ray-tube display system may be used to assure the completeness of the results even with very complex spectra. The code has been used with a variety of spectra from Ge(Li) detectors of varying resolution and active volume. The performance is evaluated with test cases and by comparing the results of complete computer and careful hand analysis of ^{177m}Lu and ^{72}As spectra. Applications to spectroscopic measurements and routine data analysis are discussed. (auth)

43571 A COMPTON-SUPPRESSED COINCIDENCE GAMMA-RAY SCINTILLATION SPECTROMETER WITH LARGE NaI(Tl) CRYSTALS. Euler, B. A.; Covell, D. F.; Yamamoto, S. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 72: 143-54(1969).

A Compton-suppressed coincidence gamma-ray scintillation spectrometer was assembled to obtain high sensitivity and selectivity in gamma-ray spectral measurements. The spectrometer is intended to satisfy requirements for the identification and estimation of low levels of gamma-ray radioactivity in a broad range of sample sizes and masses containing moderately complex mixtures of gamma-emitting radionuclides. The spectrometer detector is made of NaI(Tl) and consists of two identical subassemblies, each of which contains a central crystal integrally packaged with, and surrounded by, an annular Compton-suppression crystal. Each central crystal is nominally $6\frac{1}{2}$" in dia. by 4" thick, and is optically coupled to a 2" thick crystal of unactivated sodium iodide (NaI). The annular crystal is $13\frac{1}{2}$" in dia. by $6\frac{1}{2}$" in length, with a nominal $6\frac{1}{2}$" dia. hole through the center. For each subassembly, the exact diameters of the central crystal and of the annular hole are such that a $\frac{3}{32}$" space exists between the outer surface of the central crystal and the adjacent surface of the annulus. This space is filled with magnesium oxide to optically decouple the central crystal from the annulus. A 9" dia. by $1\frac{3}{4}$" thick NaI(Tl) backscatter-suppression detector can be optionally included as part of this detection system. Other components of the spectrometer are the photomultiplier assembly; the detector mount and shield; the amplification and gating circuitry; and the pulse height analyzer. The spectrometer detector response in the following modes of operation is presented: (1) gamma sum; (2) gamma-gamma coincidence; (3) gamma-gamma coincidence sum; (4) beta-gated gamma sum. The detector qualities evaluated were resolution, background, degree of Compton-suppression, efficiency, and relative sensitivity. (auth)

43572 A $\pi\sqrt{2}$ IRON-FREE MAGNETIC BETA SPECTROMETER WITH 50-cm MEAN RADIUS. Baudry, A.; Moussa, A. (Institut des Sciences Nucleaires, Grenoble, France. CEN, Grenoble, France). Nucl. Instrum. Methods, 72: 167-72(1969). (In French).

A 50-cm radius iron-free double focusing $\pi\sqrt{2}$ Chalk-River type beta spectrometer is briefly described. The energy range is 3 keV-3.6 MeV. The highest resolution $\Delta p/p$ achieved is 1.4×10^{-4}. Performances in coincidence studies are also discussed. (auth)

43573 THE USE OF AN ANALYTICAL RESPONSE FUNCTION FOR UNFOLDING BETA SPECTRA. Tsoulfanidis, N.; Wehring, B. W.; Wyman, M. E. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 73: 98-102(1969).

The generation of an empirical, analytical response function for the measurement of electron energy by a thin plastic scintillator, the agreement between the response function and internal-conversion electron measurements, and the use of the response function for unfolding time-dependent beta energy spectra are described. The source of the beta spectra was the beta decays of fission products produced by the thermal-neutron fission of ^{235}U. Results are given for the equilibrium beta spectrum. (auth)

43574 A MOVING-TABLE MOESSBAUER SPECTROMETER. Broadhurst, J. H.; Guest, G. H.; O'Connor, D. A.; Shakespeare, E. C.; Shaylor, H. R. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 73: 275-9(1969).

A motion device for Mössbauer experiments is described consisting of a large moving stage supported on air bearings and driven by a servo-controlled hydraulic piston. The displacement of the table is detected using optical gratings. Velocity stability and reproducibility is within 0.1% over a range 0.01 to 25 mm s^{-1} (auth)

43575 A Ge(Li)–Ge(Li)–NaI(Tl) COINCIDENCE SPECTROMETER SYSTEM FOR (n,γ) STUDIES. White, D. H.; Birkett, R. E. (Univ. of California, Livermore). Nucl. Instrum. Methods, 73: 260-8(1969).

A spectrometer system has been constructed to study 0.06–12 MeV neutron-capture γ-rays produced at the thermal-beam facility of the Livermore Pool Type Reactor. The system consists of two spectrometers, designed to cover the low-energy (0.06–2.5 MeV) and high-energy (2–12 MeV) portions of the spectrum. The low-energy system consists of a Ge(Li) detector surrounded by a NaI (Tl) anti-Compton shield, operated in anticoincidence. The high-energy system consists of a Ge(Li) detector flanked by two NaI(Tl) counters and operated in the coincidence mode as a three-crystal pair spectrometer. These systems are operated independently, or in coincidence. In the latter case, certain NaI(Tl) modes must be disengaged to obtain adequate coincidence efficiency. An automated pulser is used for linearity calibration and stabilization. Coincidence data are processed by a 4096-channel three-parameter pulse-height analyzer, buffered onto magnetic tape, and analyzed off-line by digital computers. (auth)

43576 EXPERIMENTAL USES OF A MOVING-TABLE MOESSBAUER SPECTROMETER. Abou-Elnasr, T. Z. A.; Begum, H. A.; Evans, M. J.; Moon, P. B. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 73: 253-4(1969).

A brief account is given of types of measurement for which a servo-controlled moving table has substantial advantages over vibrational motion spectrometers. (auth)

43577 X-RAY SPECTROSCOPY RELATED TO THE DETERMINATION OF ELECTRON-CAPTURE RATIOS. Bosch, H. E.; Fariolli, M. A.; Martin, N.; Simon, M. C. (Laboratorio de Radiaciones, Buenos Aires). Nucl. Instrum. Methods, 73: 323-32(1969).

The methods employed for measuring LM/K capture ratios were analyzed and the corresponding data were compiled in different tables. An alternative method is introduced here using very thin NaI(Tl) crystals to detect x-rays, in conjunction with Ge(Li) counters for gamma-rays. A triple coincidence arrangement was used. Calibration in energy and absorption corrections were made. The particular transitions of ^{133}Ba to ^{133}Cs (437 keV level), ^{57}Co to ^{57}Fe (136 keV level), and ^{57}Co to ^{57}Fe (706 keV level) were studied. The values of the LM/K ratios obtained were 1.15 ± 0.08, 0.15 ± 0.02 and 0.088 ± 0.040, respectively. When possible, Q-values were derived from the data obtained and compared with mass-table predictions. (auth)

43578 HELIUM-JET RECOIL TRANSPORT METHOD. MacFarlane, R. D.; Gough, R. A.; Oakey, N. S.; Torgerson, D. F. (Texas A and M Univ., College Station). Nucl. Instrum. Methods, 73: 285-91(1969).

The helium-jet recoil transport method has been improved for the study of nuclei with half-lives less than 1 msec. Effects of the thermalizing medium, turbulence and properties of the gas jet on the collection speed and efficiency have been studied using short-lived α-emitters produced in heavy-ion reactions. Possibilities for on-line chemical separations are discussed. (auth)

43579 ON THE APPLICATION OF THE PULSE-HEIGHT DISTRIBUTION OF SINGLE-ELECTRON PULSES AS THE REFERENCE DISTRIBUTION FOR STABILIZING A SINGLE-CHANNEL SCINTILLATION SPECTROMETER, II. Seifarth, H. (Institut fuer Elektronik, Bereich Forsching, Dresden). Kernenergie, 12: 61-7(Feb. 1969). (In German).

The stabilized single-channel scintillation spectrometer is described. Its operation and electronic construction are reported. The properties of the stabilized spectrometer are given and the experimental results obtained are outlined. The statistical characteristics are discussed. (J.S.R.)

43580 SPURIOUS GROUPS IN ASSOCIATED GAMMA RAY TIME-OF-FLIGHT SPECTRA. Joy, T. (Univ. of Manchester, Eng.). Nucl. Instrum. Methods, 73: 220(1969).

Attention is drawn to spurious neutron groups in associated gamma ray time-of-flight spectra. Their origin and elimination are discussed. (auth)

43581 FOURIER METHOD IN SLOW NEUTRON TIME-OF-FLIGHT SPECTROMETRY. Virjo, A. (Technical Univ., Helsinki). Nucl. Instrum. Methods, 73: 189-99(1969).

The Fourier method, as it is understood here, consists of first measuring the Fourier transform H(f) of the time-of-flight spectrum h(t) in equally spaced frequency points and then forming an estimate for the spectrum itself by Fourier synthesis. The problem of measuring H(f) at discrete frequencies with the help of a periodically modulated incoming beam and a multichannel analyzer is first discussed, and explicit expressions are derived for a least-squares estimation of H(f) from the analyzer data. The construction of an estimate for h(t) is then considered, with special emphasis on the "filtering problem," i.e., on getting a resolution function, that has small side lobes but is nevertheless narrow. An expression is also presented for the standard deviation of the h(t) estimate. (auth)

43582 THE APPARENT VARIATION OF THE MEASURED K/LMN RATIO WITH SOURCE–SILICON DETECTOR GEOMETRY. Planskoy, B. (Birkbeck Coll., London). Nucl. Instrum. Methods, 73: 205-9(1969).

While using LIDS detectors for measuring internal conversion spectra in which the L, M and N lines were not resolved, a striking decrease in the K/LMN ratio was observed as the solid angle, Ω, subtended by the detector at the source, was increased. This observation is explained by assuming the presence of coincidences in the detector between K-electrons and their associated K-X-ray photons. Calculations of the K/LMN ratio as a function of Ω based on this assumption, are shown to be in good agreement with experimental values. For ^{137}Cs the measured ratios at Ω = 0.025π and Ω = 1.66π sterad give values of 4.30 and 1.89 respectively and for ^{109}Cd the ratios at these angles give 0.76 and 0.40 respectively, where ratios at Ω = 0.025π are the "true" values. The implications of the results for electron spectroscopy are discussed and a method of making use of the coincidence effect for measuring electron collection efficiencies, is suggested. (auth)

43583 LEAST-SQUARES RESOLUTION OF GAMMA RAY SPECTRA RESULTING FROM INTERFERING RADIOACTIVITIES. Quittner, P. (Central Research Inst. for Physics, Budapest); Wainerdi, R. E. Nucl. Instrum. Methods, 74: 33-8(1969).

A general method is described by which a linear least-squares resolution of complex gamma spectra and quantitative activation analysis can be performed with good accuracy, even in the presence of different interfering activities, and when radioisotopes having different half-lives are produced from the same standards. Its application is shown in the analysis of rock samples. (auth)

43584 FAST NEUTRON SPECTROSCOPY BY PROTON-RECOIL PROPORTIONAL COUNTERS. Werle, H.; Fieg, G.; Stegemann, D. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie, 14: 333-7(1969). (In German).

In the past years the neutron spectra of a series of fast cores at the assemblies SNEAK, STARK, and SUAK have been measured using proton-recoil proportional counters. The method and the evaluation procedure are described, and some problems with regard to the accuracy of the method are discussed. (auth)

43585 AUTOMATIC GAIN CONTROL SYSTEM. Matoba, M.; Kumabe, I. (Kyoto Univ.). Nucl. Instrum. Methods, 74: 70-6 (1969).

An automatic gain control system is described. The binary information in the ADC of the multi-channel PHA is transferred to an analog error signal and fed back to the ramp generator of the ADC. The system parameters were determined using feedback theory, and were compared with experimental results. The performances as expected were obtained. (auth)

43586 CORGAM: A CORRELATION ALGORITHM FOR GAMMA-RAY SPECTRA. Eckhoff, N. D. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods, 74: 77-85(1969).

A correlation algorithm was developed that allows reference gamma-ray spectra to be correlated with a complex gamma-ray spectrum. The standard deviation for each correlation analysis estimator includes variance contributions from both the reference and complex gamma-ray spectra. Only reference gamma-ray spectra significant at a pre-selected level are retained in the analysis. (auth)

43587 ROUTING UNIT FOR MEASUREMENTS ON SHORT-LIVING ISOMERS. Demuynck, J.; Uyttenhove, J. (Rijksuniversiteit, Ghent). Nucl. Instrum. Methods, 74: 97-100(1969).

An apparatus for investigations on short-living isomers in the region of msec and μsec is described. By measurement of a gamma-ray spectrum in consecutive time intervals, a maximum of information on energy and time is obtained. (auth)

43588 IN-DEPTH LOCALIZATION OF BETA-EMITTING ISOTOPES WITH A SEMICONDUCTOR DETECTOR SPECTROMETRIC ASSEMBLY. Melloni, M.; Rechenmann, R. V.; Ringoet, A.; Van de Geijn, S. C.; Wilthagen, R. J. C. (EURATOM–ITAL, Wageningen, Netherlands). Nucl. Instrum. Methods, 74: 101-8 (1969).

A method is described, which permits the measurement of layer thicknesses and the in-depth localization of β-emitting

isotopes in live and inert material. It is based upon the measurement of the energy loss ΔE due to the presence of an absorbing layer between the source and the detector. The E_{max} value of an allowed continuous spectrum, eventually after passage through such a layer, is found by extrapolating the Kurie-plot for a selected optimum energy region. For layers of known thickness, excellent agreement is observed between the energy losses determined experimentally using a semiconductor detector assembly, and the theoretical ΔE values calculated from the Landau equation. The method has been particularly applied to ^{45}Ca. In this instance localization in a range of depths from ≈20 to ≈400 μm is possible with an accuracy of about 10 μm. (auth)

43589 NONDESTRUCTIVE BURN UP DETERMINATION BY γ-SPECTROSCOPY. PART 1. AN AUTOMATIC DEVICE FOR THE DETERMINATION OF BURN UP PROFILES IN FUEL RODS. Marten, R.; Rosomm, H. (Institut fuer Reaktorphysik, Geesthacht/Elbe, Ger.). Atomkernenergie, 14: 339-41(Sept.-Oct. 1969). (In German).

An automatically working γ-scanning device for the determination of burn up of fuel rods is described, that permits measurements in steps down to 0.02 mm. The equipment consists of a scanning machine, a collimator system, and a Ge-Li-spectrometer. (auth)

43590 LARGE MAGNETIC SPECTROMETER FOR INTERNAL CONVERSION ELECTRONS EMITTED IN THE (nγ) REACTION). Panin, Yu. N.; Pelekhov, V. I.; Turguntaev, T. I. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 670-5 (Apr. 1969). (In Russian).

A new spectrometer, similar to the earlier instrument was installed in the IRT-M reactor of the Kurchatov Institute for studying the internal conversion electrons. The instrument which has a mean electron orbit radius of 60 cm, was designed for measuring internal conversion electrons throughout the energy range encountered in the de-excitation of nuclei; for the present it will be used for investigations in the ~1.5-MeV electron energy range. The target of the spectrometer is located in the external beam of the reactor; the internal conversion electrons are focused from the target in the opposite direction with respect to the beam and are recorded by two coincidence counters. To reduce the γ-radiation background from the reactor. The electron-optical system of the spectrometer itself has an intermediate focal plane placed in the opposite direction with respect to the magnetic fields of the two identical electromagnets each of which is able to focus the electrons at an angle of $\pi\sqrt{2}$. The resolution of the instrument was determined by comparison with the relative half-width of the K 661 and K 7210 lines corresponding to the transitions in ^{137}Ba and ^{150}Sm respectively. Operation of the instrument is illustrated on the basis of the internal conversion electron spectrum of ^{150}Sm, excited by the thermal neutron capture in ^{149}Sm. (TTT)

43591 ABSOLUTE ENERGY CALIBRATION OF SEMICONDUCTOR DETECTORS FOR FISSION FRAGMENTS FOLLOWING THE METHOD OF THE CORRESPONDING POINTS. Kashukeev, N.; Drazhev, M.; Pancheva, N.; Chikov, N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 91-7(1969). (In Russian).

An absolute energetic calibration of silicone surface barrier detectors for fission particles following the method of the corresponding points, is carried out. Only points satisfying the criterion for method application were used for calibration. The calibration constants were calculated. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 44619 and 44667.

43592 (BNL-13906) APPLICATION OF X-RAY TRANSITION RADIATION TO THE DETECTION OF SUPER HIGH ENERGY PARTICLES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). [1969]. 12p. (CONF-690814-1). Dep. CFSTI.

From 11th International Conference on Cosmic Rays, Budapest, Hungary.

The development of a unique technique for detection of relativistic particles which make use of the x-ray transition radiation is described. Preliminary measurements of the transition radiation in the x-ray region produced by a 2-GeV positron beam passing through a stack of 231 aluminum foils are reported. (W.H.K.)

43593 CHERENKOV COUNTER TIME-OF-FLIGHT TELESCOPE. Roberts, A. (National Acceleratory Lab., Batavia, Ill.); Eartly, D. Nucl. Instrum. Methods, 73: 336-8(1969).

A time-of-flight telescope of two self-coincident, liquid, inverse threshold Fitch-type Cherenkov counters has been used in a high flux 900 MeV/c unseparated, negative beam ($K^-/\pi^- \approx 1/800$) to select the K^- with a signal purity greater than 99.5%. (auth)

43594 SOFTWARE SYSTEM FOR THE ON-LINE MEASUREMENT OF BUBBLE-CHAMBER PICTURES. Tenner, A. G. (Univ., Amsterdam). Nucl. Instrum. Methods, 73: 339-46(1969).

Bubble chamber pictures are measured on conventional measuring tables which are connected to a computer. Both on-line operations and subsequent computations for the analysis of the data are carried out by this computer. A description is presented of the operational system and of the software implementations necessary for the concurrent performance of a variety of tasks. (auth)

43595 DETERMINATION OF IONIZATION DENSITY OF PARTICLE TRACKS WITH A VIDICON. Gezelter, J. (Purdue Univ., Lafayette, Ind.). Nucl. Instrum. Methods, 73: 109-16 (1969).

Gap and blob lengths of particle tracks in a D_2 bubble chamber were measured with a device that uses a vidicon camera on a scanning table as a sensor. Results of two analysis methods which use both the mean blob length and the mean gap length of each track are compared with the results of the commonly used method which relies solely on the mean gap length. Utilization of the blob information increased, by a factor of 4, the number of dark tracks (1.3 < projected ionization < 1.8) that could be resolved from minimum ionizing tracks (1.0 < projected ionization < 1.05). (auth)

43596 OPTICAL SYSTEM FOR PRECISION SPARK CHAMBER SPECTROMETER. Romanowski, T. A. (Argonne National Lab., Ill. Ohio State Univ., Columbus); Hayes, E. R.; Terandy, J.; Reibel, K. Nucl. Instrum. Methods, 73: 117-21(1969).

Criteria, design and the performance of an optical system for a large spark chamber spectrometer capable of measuring momenta in the range of 300–1000 MeV/c to about ±2% and the portion of sparks and fiducials in space to ±½ mm is described. The system is equipped with a grid of fiducials made of electroluminescent panels surrounding the spark chambers. The spark location in space is obtained by interpolation between the local fiducials. The optical system has been stable during the course of a year and a half and showed no deterioration in the precision of locating sparks over that period. (auth)

43597 KINEMATIC FITTING OF NEUTRON TARGET REACTIONS IN A DEUTERIUM BUBBLE CHAMBER. Campbell, J. R.; Morton, W. T.; Negus, P. J. (Univ. of Glasgow). Nucl. Instrum. Methods, 73: 93-7(1969).

Procedures for fitting reactions on a neutron target in a deuterium bubble chamber are compared. The method in which the spectator proton is assumed to have three zero components of momentum before kinematic fitting is shown to be satisfactory for 4C events. Although the same technique yields fitted values for the proton momentum and direction which are less satisfactory for 1C events it is shown to have some advantages compared with other methods and the nature of the reliable information which may be obtained from this type of event is investigated. (auth)

43598 DEVELOPMENT OF HELIUM-FILLED STREAMER CHAMBER SYSTEM. Stetz, A. W.; Perez-Mendez, V. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 73: 34-40 (1969).

Development of a helium-filled streamer chamber system is described. Calculations of streamer formation are carried out to determine high voltage pulse requirements. It is found that a Marx generator is adequate to drive chambers of intermediate size if an image intensifier is used to view the streamers. A one-meter streamer chamber system employing a 350-kV Marx generator is described. This system was used in a recent cyclotron experiment to record 5×10^5 pictures with good resolution and reliability. (auth)

43599 TREATMENT OF SEARCH STATISTICS. Auslaender, J. S. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 74: 52-60(1969).

For the method of double or multiple scan in visual detectors (or coincidences in counter work) the reliability of different estimates of the actually present number of events and its expectation value is discussed. It is shown that a method recently proposed as universally valid for visual detectors is in fact also limited to not too small populations and not too low scanning efficiencies. (auth)

43600 X-RAY TRANSITION RADIATION APPLIED TO THE DETECTION OF SUPERHIGH-ENERGY PARTICLES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.); Wang, C. L.; Prunster, S. Phys. Rev. Lett., 23: 496-8(Sept. 1, 1969).

Preliminary measurements of the transition radiation in the

x-ray region indicate that an average of 12 x-ray photons are produced by a single positron of 2-BeV energy traversing a stack of 231 thin aluminum foils. This number is large enough to indicate that it is feasible to use the x-ray transition radiation for the determination of the relativistic factor γ rather than β of superhigh-energy particles. Such an application may well provide a unique method for distinguishing monoenergetic particles in the superhigh-energy region. (auth)

43601 GIANT BUBBLE CHAMBERS. Lagarrigue, A. (Ecole Normale Superieure, Orsay, France). J. Phys. (Paris), 30: Colloq. C2, 47-55(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

In a first part it is shown why physicists have proposed the building of giant bubble chambers. The main characteristics of hydrogen and propane bubble chambers are examined. Some technical problems concerning the construction (magnetic field superconductor, lighting and photography) are briefly discussed. Finally all giant bubble chambers in construction or in project in the different laboratories are described. (auth)

43602 AUTOMATIC IONIZATION MEASUREMENT IN BUBBLE CHAMBERS. Bloch, M. (College de France, Paris). J. Phys. (Paris), 30: Colloq. C2, 70-7(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The data analysis of bubble-chamber experiments requires, for some of them, measuring devices which combine high precision, ionization measurement capability and high yield. The College de France HPD system has now analysed several experiments for more than a year. The system is described and its performance discussed. (auth)

43603 CONFERENCE ON EXPERIMENTAL METHODS IN NUCLEAR PHYSICS AND PARTICLE PHYSICS, STRASBOURG, 4–6 DECEMBER 1968. J. Phys. (Paris), 30: Colloq. C2, 1-96 (May-June 1969). (In French and English). (CONF-681208).

Separate abstracts are prepared for each of the 13 papers. (C.E.S.)

For abstracts of individual papers see: 43561–43563, 43601, 43602, 43644, and 44796–44802.

Radiation Dosimeters

43604 (COO-1105-150) Ca SO_4 AS A TL NEUTRON DOSIMETER. Podgorsak, Ervin; Hevezi, James M.; Cameron, John R. (Wisconsin Univ., Madison. Dept. of Physics). Aug. 1, 1969. Contract AT(11-1)-1105. 9p. Dep. CFSTI.

The response of thermoluminescent calcium sulfate doped with manganese and sodium and also with manganese, sodium, and depleted uranium for dosimetry of fast neutrons, thermal neutrons, and gamma radiation is reported. (W.H.K.)

43605 (NYO-3510-10) BIOLOGICAL AND CLINICAL DOSIMETRY. Annual Progress Report, July 1, 1968–June 30, 1969. Laughlin, John S. (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-3510. 94p. Dep. CFSTI.

The current transformer monitor system developed for the 30 nanosecond field emission electron source was improved significantly. A scheme whereby the monitor pulse is directly integrated using a diode-capacitor combination has eliminated the drift problem previously associated with the use of a peak reading voltmeter. It was demonstrated that the use of adjustable length vacuum columns surrounding the beam produced by the dual channel 3 nanosecond field emission source improves beam stability. A monitor system for the 3 nanosecond system was developed, using a beam current pick-up loop. A degree of correlation between this monitor and Faraday cup was demonstrated to an accuracy of the order of ±1%. Preliminary results show a promising degree of correlation with survival of bacterial cells exposed to single intense radiation pulses. Preliminary investigation was made of the characteristics of neutron beams produced by several different reactions with the SKI 30-inch cyclotron. Intercomparison of a developmental ionization chamber for high energy electrons and x rays with the Fricke $FeSo_4$ dosimeter has yielded a high degree of correlation. Facilities for lithium drifting germanium were completed at Sloan-Kettering Institute including conventional cryogenic requirements. The first diode was lithium drifted successfully, preparing the way for the production of a germanium matrix using the previously developed orthogonal strip geometry. A cryostat specially tailored to this application is near completion. The aim of this work is the production of a semiconductor gammacamera with (3 × 3) mm spatial resolution. Miniature silicon diode probes were constructed using specially fabricated p-n junction diodes. These were used in routine in vivo measurements. (auth)

43606 (UR-49-1133) USE OF INDICATORS IN A CHLORAL HYDRATE DOSIMETRY SYSTEM. Quiriconi, Paula Marie (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1969. 59p. Dep. CFSTI.

Thesis.

The feasibility of using pH indicators in an aqueous chloral hydrate dosimetry system to make quantitative measurements of photon-tissue dose in a range of 100 to 5,000 Rads was studied. Irradiation of chloral hydrate ($CCl_3CH(OH)_2$) in solution produces trace amounts of hydrochloric acid. It was found that small changes in acidity due to low dose irradiations could not be sensitively demonstrated by following spectral changes of the included indicator. Amplification of the system's response through a spectral change in the dye is not possible because of the necessity of having to work below pH 5.3 to avoid CO_2 gas absorption. Reduction in yield per Rad due to the presence of small quantities of dye in solution, and dose rate dependence of the radiolytic yield of acid below 50 Rads per minute are two additional limitations which make this dosimetry system impractical. (auth)

43607 (UR-49-1135) CHLORAL HYDRATE AS A NEUTRON DOSIMETER. Dziak, Rose Mary (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1969. 50p. Dep. CFSTI.

Thesis.

Studies were made on the response of aqueous solutions of chloral hydrate ($CCl_3CH(OH)_2$) to photon radiation and to thermal and fast neutrons. The amount of hydrochloric acid produced upon irradiation was determined by conductivity measurements. The yield of acid/rad of photon radiation was shown to increase with increasing initial concentration of chloral hydrate up to 1M. The variation of the response with the temperature was almost completely eliminated by the addition of 0.025–0.1% resorcinol. A yield dependence on dose rate below 50 rads/min was observed. The response to thermal neutrons was linear with the amount of energy absorbed but was dependent on the dose rate of the neutron radiation. The response to thermals was 0.4 that of gammas when the comparison is made with the neutron and gamma radiation delivered at the same dose rate. Preliminary studies with fast neutrons show that chloral hydrate solutions were surprisingly insensitive to radiation of this type. (auth)

43608 AUTOMATIC COUNTER FOR PROTON TRACKS IN NUCLEAR EMULSIONS. Moss, G. H.; Rae, J. B.; Wheeler, D. W. R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 73: 269-74(1969).

An automatic machine has been constructed to count proton-recoil tracks in nuclear emulsions used as personal dosemeters for fast neutrons. The machine uses an opto-mechanical fast scanning arrangement to examine 0.8 mm^3 of emulsion in 12 min. A maximum number of 60 track plates can be examined automatically in 12.5 h. To discriminate between proton tracks and aggregates of grains in the emulsion, it is necessary to ignore track lengths less than 5 μm, corresponding to 0.5 MeV protons. The energy response shows reasonable agreement with that expected by calculation, and calibration of the dosemeter/reader combination by Pu–Be neutrons gives a linear relationship up to 4.5 rem with a background of 0.1 rem. (auth)

43609 CALIBRATION OF FILM DOSIMETERS WITH BETA PARTICLES OF DIFFERENT ENERGIES. Metalli, P. (CNEN, Rome); Lesaca, R. M.; McCannon, D. G. Fis. Sanit. Prot. Radiaz., 12: 28-34(Jan.-Mar. 1968). (In Italian). (RT/BIO-(69)1).

A method for the calibration of personnel photographic dosimeters with exposure to beta particles of diverse maximum energy is described. The method used sources constituted of simple solutions of isotopes which can be recovered. The results obtained with two types of films of different sensitivities and four radioisotopes with maximum energy from 0.254 to 2.320 MeV are described. A significance dependence of the photographic yield on the energy, such as to cause an under-evaluation of the absorbed dose if the calibration is made with a single energy, was shown. (tr-auth)

43610 A SCINTILLATION TYPE GAMMA-RAY DOSIMETER WITH LOW NEUTRON SENSITIVITY. Takeuchi, S.; Itoh, K.; Sekiguchi, A. (Tokyo Univ.). Nucl. Instrum. Methods, 73: 148-56(1969).

A scintillation type dosimeter with high gamma-ray sensitivity is described. Design considerations are neutron sensitivity, energy response, dynamic energy range and simplicity of the circuit. A method to measure the average energy is also described. (auth)

43611 THE PHYSICAL AND TECHNOLOGICAL REQUIREMENTS OF X-RAY AND GAMMA-RAY DOSIMETERS. Rothe, H.; Guehne, F.; Willuhn, K.; Hecker, O. (Deutsche Amt fuer Messwesen und Warenpruefung, Berlin). Kernenergie, 12: 170-6 (May 1969). (In German).

According to the decree on metrology issued in the German Democratic Republic, dosimetric measuring devices employed in radiation protection and in medical uses of radiation are subjected to obligation of gaging. The requirements to construction type and measuring properties of X-ray and gamma dosimeters are advertised and discussed, as they are included in the gaging instructions elaborated by the German Board for Metrology and Goods Testing. These requirements, first of all, apply to dosimeters including ionization chambers and counters, but are of fundamental importance also for the development and application of other dosimetric systems and other qualities of ionizing radiations. (auth)

43612 GLASS DOSIMETER FOR MEASURING THE ABSORBED DOSE IN CRITICAL ORGANS. Yokota, Ryosuke; Muto, Yuhei (Tokyo Shibaura Electric Co.). Hoken Butsuri, 4: 497-501(June 1969). (In Japanese).

Glass dosimeter developed by Piesch for measuring the absorbed dose in critical organs, in which only one FD-P8-1 glass was encased in a suitable badge case, was examined for the case of FD-3 glass, FGD-6 type fluorimeter, standard Japanese man phantom, and a badge case manufactured by us. This experiment confirmed the same validity for this case as well as the case of FD-1 glass, FGD-3B type fluorimeter and Alderson man phantom which were used by Piesch. The merits of this glass dosimeter against other dosimeters are discussed from the view point of the personnel dosimetry for radiation protection. (auth) (NSA of Japan)

43613 THERMOLUMINESCENCE: THEORY AND APPLICATIONS. Lancaster, Donald E. Electron. World, 81: 43-6(Mar. 1969).

The nature, measurement, and applications of thermoluminescence are reviewed. How thermoluminescence indicates the previous radiation exposure of a material is explained. Thermoluminescence can provide a more sensitive radiation indicator than either a Geiger or a scintillation counter, since it responds to the total dose through time instead of making an instantaneous or short-term measurement. For nuclear prospecting and for radioactive deposit mapping, thermoluminescence can be a highly sensitive indicator. To monitor personnel working near a nuclear reactor or other radioactive source, badges using lithium fluoride may be worn. Special finger rings are also used where people might expose only their hands to radiation hazards. These badges and rings are annealed before being issued; the resultant thermoluminescence indicates the dose the person wearing the badge has received. Compared to the film-badge technique, thermoluminescence is more accurate and less dose dependent at low dose rates. A new application of thermoluminescence is in archeology where it can provide absolute calendric dating of ancient pottery. When a pot is fired, it is also conveniently annealed, and its past radiation history is erased. From the firing on, the slight Th and U impurities in the clay emit high-energy particles which fill the lattice with electrons. To find the age of the pot, its thermoluminescence is measured. The dose is found which produces the same amount of thermoluminescence by annealing and reradiation with a known dose. (BBB)

Radiometric Instruments

Refer also to abstract 44782.

43614 MEASUREMENT OF SOIL HUMIDITY WITH NEUTRON-SCATTERING HUMIDITY MEASURING INSTRUMENT. Toeroek, Istvan (Orszagos Mezogazdasagi Minosegvizsgalo Intezet, Budapest). Atomtech. Tajek., 11: 580-4(Nov. 1968). (In Hungarian).

A description of the experiments using the neutron scattering moisture measuring instrument prepared by the Research Institute of Soil Science and Agrochemistry of the Hungarian Academy of Sciences is presented. (auth)

43615 NEW ACHIEVEMENTS IN THE NEUTRON MOISTURE MEASUREMENTS. Nagy, Arpad. Atomtech. Tajek., 11: 421-33(Aug. 1968). (In Hungarian).

Using a computer program, developed in the Central Research Institute of Physics, the effects of source-to-detector distance and the density of the medium on the calibration curve are determined. Determination of the calibration curve for a special use makes the instrument construction easier. The measurement of the moisture content of foundry sand is used as an example. (auth)

43616 SOLID ANGLE SUBTENDED AT A POINT BY A CIRCULAR DISK. Gardner, R. P.; Carnesale, A. (North Carolina State Univ., Raleigh). Nucl. Instrum. Methods, 73: 228-30(1969).

The solid angle subtended at a point by a circular disk can be well-represented by the product of an analytical expression and a slowly-varying correction factor. (auth)

43617 FOG DENSITY MEASUREMENT BY X-RAY SCATTERING. Bayly, John G. (to United States Atomic Energy Commission). U. S. Patent 3,470,372. Sept. 30, 1969.

An apparatus for determining the density of a light substance confined within a material of greater density is described. It employs a source of mono-kinetic photons with an energy sufficient to pass through the greater density material and then pass out again after Compton scattering by electrons in the light substance. The photons are collimated both before and after scattering and those scattering at a predetermined angle are detected along with those photons scattered other than by the single Compton scattering. (AEC)

43618 FUNDAMENTAL STUDIES ON RADIATION THICKNESS GAGE. 3. ANALYSIS OF STATISTICAL ERRORS. Koyanagi, Takami (Niigata Univ., Nagaoka, Japan). Radioisotopes (Tokyo), 18: 299-304(Aug. 1969). (In Japanese).

The errors in question are caused by many factors, such as the counting rate of radiation, pulse height spectrum induced in a radiation detector, transfer function of a measuring system and absorption characteristics of samples. The relationship between these factors has been given by a formula. The statistical properties of the output wave have been proved to be similar to the Gaussian noise. Using these properties, a formula has been induced for calculating the optimum intensity of radiation to detect a given small change of thickness. (auth) (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 43478, 43998, 44076, and 44363.

43619 (CEA-CONF-1242) USE OF CALCULATORS IN NUCLEAR PHYSICS. Mougel, J. F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1968]. 27p. (In French). (CONF-680642-3). Dep.

From International Conference on Electronics and Automation, Herceg Novi, Yugoslavia.

The selection of a type of calculator for a family of experiments can lead to an acquisition and processing of data very competitive with traditional methods of acquisition and processing. In order to make this choice it is necessary to define what, in the classical material, can be replaced with a calculator and to study the various possibilities of connection and programming. These three goals are the purpose of the present study. The cabled program systems and the registered program system are compared. The methods of connecting the calculator with the experimental apparatus can be divided into those connections established under the control of the program for the transfer of orders or of data between the control unit or the memory and the peripheral equipment; those connections established under the control of the peripheral equipment between it and the memory; and interruptions. The structures, functions, and response times of these three methods are described. The programming is then considered. The experimental characteristics for a calculator integrated in a measurement chain are outlined. Some calculators used in nuclear physics and practical examples of their use are summarized. (J.S.R.)

43620 (CONF-681063) SYMPOSIUM ON ELECTRONICS IN MEDICINE. Proceedings of the Symposium, Ljubljana, Yugoslavia, 9–12 October 1968. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). 235p. (In Several Languages). Dep.

Separate abstracts were prepared for three of forty-eight papers presented. Forty-five of the papers on instruments and techniques were not within the scope of NSA and were not abstracted. (B.G.D.)

For abstracts of individual papers see: 43515–43517.

43621 (INR-1021) TEMPERATURE STABILITY OF THE VOLTAGE STANDARD USING ZENER DIODES. Pazdzierski, Jerzy (Inst. of Nuclear Research, Warsaw (Poland)). 1968. 19p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The compensation methods of the Zener diode voltage change caused by the variation of the temperature are discussed. Simple circuits for temperature compensation of the voltage standard

realized on the available Zener diodes are given and methods of selection assuring temperature stability better than 0.005 %/deg. are described. (auth)

43622 (LA-4041) AEC STANDARD MODULES FOR FIELD INSTRUMENTATION. Fullwood, Ralph R. (Los Alamos Scientific Lab., N. Mex.). June 1, 1969. Contract W-7405-eng-36. 42p. Dep. CFSTI.

A series of AEC standard modules has been designed for field instrumentation of nuclear explosive experiments. The objectives of this work were to provide systematic instrumentation logic so that technicians can set up a recording station by simply obeying logical rules, to provide digital control where possible, and to achieve a design compatible with other AEC standard, commercial, or laboratory instrumentation modules. The operation of individual modules is described and as an example, a field configuration using plate film that records with automatic oscilloscope calibrations and two forms of moving film that record with automatic calibrations is presented. (auth)

43623 SELF-ENERGIZING BEAM POSITION STABILIZER FOR LOW VOLTAGE ACCELERATORS. Walker, D. A. S. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods, 72: 220-2(1969).

Two resistors, connected between a pair of pickup pins and ground, develop voltages which are proportional to the current striking each pin. These voltages are fed back to a pair of electrostatic deflection plates to maintain stable beam position about the pins. Experimental results obtained with an isotope separator are reported and possible applications to higher energy facilities are briefly discussed. (auth)

43624 IONIZATION GAGE CONTROLLER FOR 10^{-4} TO 10^{-12} TORR RANGE (May 10, 1968) (Engineering Materials). (New York Operations Office (AEC), N. Y.). (CAPE-1908).

12 drawings

The versatile research controller capable of measuring gas pressures in the 10^{-4} to 10^{-12} torr range at very low currents consists of an electrometer, transformer, power supplies, six V battery chargers, and a selector switch. The electrometer is a Keithley model 602 with a range of 10^{-14} to 0.3 A with a max error of ±4% full scale. One power supply is in the 0 to 50 V dc negative range and the other is in the 0 to 500 V dc positive range. Filament emission current may be varied from 0.1 μA to 50 mA permitting operation at very low ion pumping speeds or at very high electron bombardment ranges. When a thoriated Ir filament is used at 10 μA, emission will result in a low temperature of 550 to 600°C. This temperature range is unfavorable for the production of atomic H making the gage useful in research concerned with the nature of the adsorbed H (atomic or molecular). (For details see TID-4100). (F.S.)

43625 LARGE MULTICHANNEL ANALYSER USING DISK MEMORY. Adam, J. P. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods, 73: 89-92(1969).

A method is described to build large histograms on disk memory and its implementation on an IBM 360-50 with 2311 direct access storage devices, allowing to build and manipulate up to 3×10^6 channels histograms, either on-line or off-line. (auth)

43626 WIDE-RANGE PULSE HEIGHT ANALYZER FOR SATELLITE APPLICATION. Cancro, C. A. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods, 73: 61-6(1969).

A wide-range pulse height analyzer with data compression readout has been developed for satellite application. The range of a basic low weight-low power drain 512-channel analyzer is greatly increased by use of multiple ranges and range selection. The readout consists of the basic pulse height analyzer count, plus a multiplying factor corresponding to the range selected. An effective overall range as wide as 25,000 is obtainable by this technique. While the detector driving the system operates over the full dynamic range, all elements of the system operates only within the limited dynamic range of the basic 512-channel analyzer. The system will accept pulses with rise times as fast as 200 ns. All circuitry was designed and developed to minimize power drain, weight and volume, and to maintain stable characteristics while unattended for periods as long as one year. The operating temperature range is -20°C to 60°C. (auth)

43627 A NOVEL COINCIDENCE METHOD: SIMULTANEOUS RECORDING OF TRUE AND RANDOM COINCIDENCES BY DOUBLE PULSES. Cho, Z. H.; Gerholm, T. R. (Univ. of Stockholm). Nucl. Instrum. Methods, 73: 67-76(1969).

A description is given of a fast coincidence method capable of detecting and subtracting the random coincidences from the total number of coincidences recorded during course of the experiment. Double pulses are formed in each channel. Their coincidences are used to determine whether the event is true or random. From the number of prompt coincidences (true plus random) the number of delayed (random) coincidences is subtracted. The method is quite unambiguous and very simple. Several advantages are seen in comparison with conventional methods. The principle suggested here has a unique resolving time, the same for true and random coincidences. The method is particularly useful in experiments where the half life of the source is short or when the source is subjected to large intensity fluctuations. The overall system and a brief circuit description are presented together with some experimental results, obtained from coincidence measurement, subnonosecond time resolution curves and angular correlations. The capability and limitations of the method are discussed. (auth)

43628 ON-LINE SMALL COMPUTER DATA HANDLING IN PULSE HEIGHT ANALYSIS AND TWO PARAMETER MULTICHANNEL COINCIDENCE DATA STORAGE. Der Mateosian, E. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 73: 77-82(1969).

The role which small on-line computers may play in nuclear spectroscopy is reviewed and a computer-analyzer combination at Brookhaven National Laboratory is described. The data handling capabilities of this combination for singles spectra and plans for its use for storing two parameter 1000 × 1000 channel coincidence data on tape are reviewed. A system for two parameter 1000 × 1000 coincidence data storage on a disc is proposed and advantages and disadvantages of the system are discussed. (auth)

43629 VERSATILE 16-CHANNEL ROUTING SYSTEM. Cuno, H. H.; Clausnitzer, G.; Nagler, U. (Univ., Erlangen-Nuernberg, Ger.). Nucl. Instrum. Methods, 72: 201-4(1969). (In German).

A flexible routing system for application in nuclear physics was constructed. A description of the circuits and some possible measurement configurations are given. (auth)

43630 MULTICHANNEL DIFFERENTIAL-DISCRIMINATOR WITH STABLE TIME INFORMATION. Lauch, J.; Nachbar, H. U. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 73: 292-300(1969). (In German).

A differential discriminator for measuring D- and DD-clipped pulses with a duration of 40 ns ... 5 μs and RC-shaped pulses with a decay time constant of max 8 μs is described. Channel level and channel width are adjustable between ±10 mV and ±2V. The discriminator allows differential and integral mode and may be triggered at a selectable point on the leading edge or the crossover point of the input pulses. The output signal may be delayed in the range of 200 ns ... 5.7 μs. The time shift depending on the pulse amplitude is only a few nanoseconds. The stable time information of the output signals provides direct controlling of fast coincidence circuits. Therefore measurements with high time resolution are possible. Pile-up signals may be rejected by a special circuit. (auth)

43631 INTEGRATED CIRCUIT INTERFACES BETWEEN NUCLEAR INSTRUMENT MODULE AND EMITTER COUPLED LOGIC LEVELS. Barna, A.; Cisneros, E. L. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 73: 347-8(1969).

Two simple high-speed interfaces using integrated circuits are described. They provide conversion between nuclear instrument module and emitter coupled logic levels. Rise times and fall times are <2.5 nsec, maximum repetition rates are 100 MHz. (auth)

43632 AN INTEGRATED FAST AMPLIFIER WITH A HIGH INPUT IMPEDANCE. Papadopoulos, L. (Laboratori di Fisica, Rome). Nucl. Instrum. Methods, 73: 186-8(1969).

A new voltage amplifier stage which has the characteristics of high input impedance and wide bandwidth is described. The detailed analysis of the circuit which amplifies 85 times with an input impedance of ≈20 kΩ and a risetime smaller than 2.5 ns is presented. This amplifier has been mounted as input stage after a filter which is used for finding the zero-crossing point in a pulse shape discrimination circuit. (auth)

43633 A WIDE-BAND PULSE MULTIPLIER. Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods, 73: 231-3(1969).

A wide-band pulse multiplier providing a multiplication of 16 over an 8:1 frequency range is described. (auth)

43634 PRECISION LOGARITHMIC DECODING CIRCUIT FOR MULTICHANNEL ANALYZERS. Marion, A.; Kaitandjian,

M. (CNRS, Orsay, France). Nucl. Instrum. Methods, 74: 45-51(1969). (In French).

An accurate logarithmic decoding unit is described. This device is specially designed for plotting the spectra given by a multichannel analyzer with a potentiometric recorder. Decoding the three most significant digits and using electronic components with high performances the accuracy of the logarithmic output attains 2×10^{-3}. (auth)

43636 CYCLE CHOICE, RESOLVING POWER CALCULATIONS, AND ANALYSIS OF HARMONICS OF AN APERIODIC RF MASS SPECTROMETER. Lall, H. B.; Gill, P. S. (Central Scientific Instruments Organisation, Chandigarh, India). Nucl. Instrum. Methods, 74: 132-40(1969).

The analysis of harmonics of an aperiodic rf mass analyzer is examined. The cycle choice of free-drift spaces, resolving power expressions, suppression of harmonic peaks and selection of retarding potential level of Bennet-type non-magnetic mass analyzer from one-stage to five-stage configurations, have been discussed. The solution of the energy modulating functions $F_1(\lambda)$ to $F_5(\lambda)$ have been obtained for various combinations of free-drift spaces, using an IBM-1620. Several new combinations of free-drift spaces have been discovered which promise to yield better performance of the analyzer. The resolving power and current efficiency of the most favorable configurations have been determined at the first harmonic level. The practically obtainable resolving power of the most promising configurations has been determined for the 90% retarding voltage level. (auth)

43636 MAGIC-ANGLE ELECTRON SPECTROMETER AT AMSTERDAM. De Jager, C. W.; Douma, F. Th.; Bruinsma, P. J. T.; De Vries, C. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods, 74: 13-19(1969).

A magic-angle ($\alpha = \frac{1}{3}\pi\sqrt{2}$) type double-focusing spectrometer ($r_0 = 65$ cm) is described. This instrument is used for electron scattering experiments with the Amsterdam 85 MeV linear electron accelerator and permits high resolution measurements (0.1%) at a large solid angle (6 mster). Scattered electrons having a momentum spread of 3% can be detected simultaneously. (auth)

43637 RADIOACTIVE ELIMINATORS OF ELECTROSTATIC CHARGES. Satorie, Zdenek; Borcevsky, Vladimir (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 15: 278-81(Aug. 1969). (In Czech).

General principles of elimination of static electricity by radioactive eliminators are discussed. Also, a list of the most convenient types of eliminators and their combination with an induction needle eliminator is given. Their preparation, measurement of the ionizing efficiency, and evaluation of data obtained are described. (auth)

43638 DIODE SENSORS FOR LIQUID LEVEL DETECTION. Pierce, William B. (to United States Atomic Energy Commission). U. S. Patent 3,465,587. Sept. 9, 1969.

A liquid level indicating device in which a plurality of diode sensors are serially connected along a probe which is vertically oriented in a liquid cryogen is described. The change in conduction of an electrical current through the diodes that are immersed in the cryogen relative to the diodes above the liquid causes a proportionate change in an electrical circuit connected in series with the diodes, thereby indicating the surface level of the cryogen. (AEC)

43639 IMPROVEMENTS IN AND RELATING TO A SIGNAL GENERATOR. Bourbigot, Jean (to Commissariat a l'Energie Atomique). British Patent 1,162,914. Sept. 4, 1969. Priority date July 1, 1966, France.

A signal generator is described which may be used as a drive circuit for a variable frequency oscillator for use in a spectrum analyzer to observe the electrical and electromagnetic oscillations produced in gas discharges and in plasmas. (W.H.K.)

43640 ANALOG-TO-DIGITAL CONVERTER. Goosey, Macolm E.; Brady, Edward R. (to United States Atomic Energy Commission). U. S. Patent 3,469,254. Sept. 23, 1969.

An analog-to-digital converter having a circuit for adding a series of reference potentials to the analog input and a series of sequentially operated switches for coupling the resultant potentials to a series of comparator amplifiers is described. Each comparator amplifier has an on-off or digital output corresponding to a single significant bit which is transmitted to a flip-flop circuit for storage and subsequent readout. (AEC)

43641 MULTI-CONTACT SELECTOR SWITCH FOR HIGH CURRENTS. Dexter, Warren L. (to United States Atomic Energy Commission). U. S. Patent 3,470,503. Sept. 30, 1969.

A selector switch capable of handling currents in excess of 1000 amperes and having a common switch contact which may be connected to any one of several circuit switch contacts is described. All switch contacts are stationary, switching being accomplished by bridging contacts which are rotated to a desired switch position and moved axially to bridge between the common contact and one of the circuit contacts. The switch may be remotely controlled. (AEC)

43642 ZUVERLAESSIGKEIT VON MESS-, STEUER-, REGEL- UND SICHERHEITSSYSTEMEN. (Reliability of Control and Safety Systems). Hofmann, Werner. Thiemig-Taschenbuecher, Band 32. Muenchen, Verlag Karl Thiemig KG, 1968. 239p. DM 16.80.

The concept of reliability is defined and the general construction of measurement, operating, control, and safety systems is described. The provisions for the reliable operation of these devices are considered. These include the guarantee of the power supply, the selection of the signal, and the reliability of the construction elements, instruments, and installation. (tr-auth)

43643 PHASE-ADJUSTMENT DEVICE FOR MULTICHANNEL ANALYZERS. Uzunov, Ivan. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 165-9(1969). (In Russian).

The necessity of introducing a phase-adjustment device in multichannel analyzers is considered. The block diagram and the principle of 1024- and 256-channel analyzers are discussed. The pulse which gives the measured time interval charges a memory condenser up to a given potential during a sufficient time. The potential thus memorized is brought to a coincidence circuit. A pulse is obtained at the output in the diagram only from the moment of arrival of the very next pulse within the time of a pulse of the standard series. This pulse assures the desired phase adjustment. (tr-auth)

43644 TREATMENT OF INFORMATION AND ON-LINE COMPUTERS: SYNTHETIC OUTPUT. Meinadier, J. P. (CEN, Saclay, France). J. Phys. (Paris), 30: Colloq. C2, 80-5(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The different problems concerning the use of on-line computers in physical experiments are reviewed. The chief points discussed are: i) nuclear experiments control: experiments on computer coupling devices; supervisors and programme organization; ii) data acquisition and real time processing; large scale multiparametric analysis; iii) man-machine communications: synthetic data outputs; programming and languages, man-machine interactions; iv) using a time-shared computer for several experiments; interconnected computer systems. (auth)

Radiation Effects on Instruments and Instrument Components

43645 STUDY OF THE CURRENT ATTENUATION INDUCED BY CONTINUOUS ELECTRON BOMBARDMENT IN A CADMIUM SULFIDE CRYSTAL. Guillien, Robert; Palz, Wolfgang; Ravelet, Serge (ENSEM, Nancy). Compt. Rend., Ser. B, 268: 1661-3(June 23, 1969). (In French).

The attenuation, by infrared radiation, of the current crossing a cadmium sulfide crystal due to constant electron bombardment was studied. (tr-auth)

43646 INTERACTION OF A POWERFUL PLASMA FLUX WITH A LASER. Bedilov, M. R. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 10, 20-1(1968). (In Russian).

A ruby rod (Al_2O_3 with 0.1% Cr^{3+}) 90 mm long and 8 mm in diameter was used in experiments with a pinch-discharge plasma having a period of 4 microseconds and a maximum current of 300,000 A. The ion and electron velocities in the plasma were almost equal (about 10^7 cm/sec) because of the quasineutrality of the plasma at approximate ion and electron concentrations of 2 to $5 \times 10^{17}/cm^3$. Spectral radiations were observed in the region of 6230 to 6750 Å with a radiation maximum belonging to the 6530 Å line. The spectra consisted of continuous and bright-line radiations whose intensity increased with increasing intensity of the plasma flux. Irradiation of the ruby crystal (more than 100 times) by the plasma flux did not lead to a noticeable change in properties of laser regeneration. Irradiation of crystals activated with neodymium or terbium showed that the optical and generating properties became much poorer on irradiation with a plasma. The generation threshold increased by two orders of magnitude. Thus, ruby lasers can operate without a change in their gener-

ating properties in plasma equipment and in space, where high plasma fluxes and radiations exist. (TTT)

43647 THE PERFORMANCE OF IMPATT DIODES UNDER THE INFLUENCE OF HIGH-INTENSITY GAMMA AND NEUTRON RADIATION. Anderson, Wayne A. (State Univ. of New York, Buffalo). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1441-2 (Aug. 1969).

IMPATT diodes were tested under the influence of up to 1.5×10^7 R/h gamma radiation and 3×10^{12} N/cm^2/s fast neutrons. Major changes were noted in power output, frequency spectrum, and current-voltage characteristics. Permanent damage and total failure resulted from this test. (auth)

43648 RADIATION-INDUCED LATCHUP IN MONOLITHIC INTEGRATED MICROCIRCUITS. Horiye, H. (Gulf General Atomic Inc., San Diego, Calif.). Radiat. Eff., 1: 197-206(July 1969).

Radiation-induced latchup in commercially available junction-isolated integrated microcircuits is reported. Four different types of construction of integrated microcircuits have been examined. They include quadruple-diffused, diffused collector, epitaxial, and epitaxial with buried layer (gold-doped). It was found that pnpn switching could be obtained between isolated components on these devices. In fact, pnpn paths were quite common in all but the last type mentioned. The current gains of the parasitic transistors involved in these pnpn paths were measured and were, in most cases, shown to indicate that pnpn switching should occur. However, important exceptions were seen. Latchup between these isolated components could be induced by a pulse of ionizing radiation even with a reverse bias on the substrate of the microcircuits. As a result of this investigation, it is concluded that the pnpn mechanism, since it is so common, is a major cause of latchup in junction-isolated integrated microcircuits. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 43285.

Basic Processes

Refer also to abstracts 43279, 43553, and 43808.

43649 (AAEC/TM-506) DNA SYNTHESIS IN HUMAN PERIPHERAL BLOOD LYMPHOCYTE CULTURES. Siagian, E. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). June 1969. 14p. Dep.

Parallel cultures were set up of whole human blood, lymphocytes separated from the same sample by methocel sedimentation and nylon wool filtration, and lymphocytes which had also been centrifuged. Each set of cultures contained the same number of lymphocytes. The results obtained by liquid scintillation counting on phytohaemagglutinin-stimulated cultures after pulse labeling with tritiated thymidine showed that cultures of whole blood from four haematologically normal donors harvested at 50, 60, and 72 hours always showed a significant increase in DNA synthesis compared to cultures of separated lymphocytes. The results suggest that the growth potential of lymphocytes is adversely affected by manipulative procedures involved in their isolation or that the presence of other cellular elements in whole blood contributes in some way to environmental changes more conducive to lymphocyte proliferation. In a second series of tests 50-hour whole blood cultures from four donors set up in culture after 20 hours storage at 6°C showed an unexpected increase in DNA synthesis varying from 1.7 to 2.2 times that found for cultures set up immediately after venepuncture or after standing for two hours at room temperature. (Australia)

43650 (TT-67-56003/6, pp 835-41) STUDIES ON LABELING OF RED BLOOD CELLS WITH ^{51}Cr. Grabowski, Ryszard; Munkner, Troels. Translated from Pol. Przegl. Radiol. Med. Nukl., 31: (1967).

The wide use of radioactive chromium in isotope studies and its applications as a cell marker prompted a study of a number of methodological variants with the aim of establishing the optimal conditions for labeling red blood cells. The isotope method of Munkner was used with ^{59}Fe and ^{51}Cr in vitro. The method is based on incubation of heparinized blood with added ^{59}Fe and ^{51}Cr. Incorporation of ^{59}Fe in blood gives an insight into the amount of plasma remaining with the red blood cells and eliminates the need of washing the red blood cells. In about 300 experiments with ^{59}Fe, Munkner found that the iron isotope does not penetrate into red blood cells. (auth)

43651 AMYOTROPHIC LATERAL SCLEROSIS STUDIES USING NEUTRON ACTIVATION ANALYSIS. Yase, Yoshiro; Kumamoto, Tetsuzo; Yoshimasu, Fumio; Shinjo, Yoshiyuki (Wakayama Medical Coll., Japan). Neurol. India, 16: 46-50 (Apr.-June 1968).

Because of the small content of manganese in the human nervous system and the delicate behavior of the manganese ion in the environment, analysis by neutron activation was undertaken on materials from the Kii Peninsula in Japan and from Guam, both areas of high incidence of motor neuron disease. The manganese content was determined in water, soil, air, plants, fish, hair of cattle, and brain specimens from a lateral sclerosis case. Tables are presented to show manganese contents of air, soil, and water. The pattern of distribution of manganese in the brain from the amyotrophic lateral sclerosis case was somewhat different from that in the control. (H.L.W.)

43652 DISTRIBUTION OF RABBIT ANTI-MOUSE THYMUS GLOBULIN AFTER INJECTION INTO MICE. Nava, Carlos; O'Kane, H. O.; Shorter, R. G. (Mayo Clinic and Foundation, Rochester, Minn.). Proc. Soc. Exp. Biol. Med., 131: 990-4 (July 1969).

Mice were injected intravenously with a mixture containing 0.104 mg each of rabbit anti-mouse thymus serum (RAMTS) labeled with ^{125}I and gamma globulin (NRG) labeled with ^{131}I. Corrections were made for the presence of blood in the excised tissues. Twenty-four hours after injection, the distributions of RAMTG-^{125}I and RAMTIgG-^{125}I were not significantly different from those of NRG-^{131}I and NRIgG-^{131}I in any of the organs examined. On the other hand, 24 hr after injection of IgG prepared by absorption with thymic tissue followed by elution, there was a significant difference between the distribution of that obtained from the anti-thymus serum and that of the IgG obtained from normal serum. The greatest degree of localization of heterologous IgG occurred in the thymus. No significant differences were found between the distributions in vivo of gamma globulin, or IgG prepared by column chromatography from heterologous antilymphoid serum, and those of fractions derived from heterologous normal serum 24 hr after injection into mice. It was concluded that the inability to demonstrate specific localization properties of these materials could be due to the very small amount of specific antibodies and the insensitivity of the method. (C.O.)

43653 SCINTILLATION COUNTING OF $^{14}CO_2$ FROM IN VITRO SYSTEMS: A COMPARISON OF SOME TRAPPING AGENTS. Duncombe, W. G.; Rising, T. J. (Wellcome Research Labs., Kent, Eng.). Anal Biochem., 30: 275-8(Aug. 1969).

It was shown that gross interference with metabolic processes can be caused by the presence of organic CO_2 trapping agents in the center well of incubation vessels. True homogeneous scintillation counting was achieved by the use of organic bases such as Hyamine, phenethylamine, and ethanolamine which are miscible with scintillation solutions. The efficiency of these trapping agents was compared with KOH, and it was found that when finely divided silica was incorporated into the scintillator before the KOH was added, the $^{14}CO_2$ recovery, using internal standardization, was most satisfactory. (E.R.B.)

43654 TRITIUM LABELING OF PROTEINS BY THE FREE-RADICAL INTERCEPTOR METHOD WITH THE AID OF ELECTRICAL DISCHARGE. White, Frederick H. Jr.; Hauck, Barbara; Kon, Hideo; Riesz, Peter (National Inst. of Health, Bethesda, Md.). Anal. Biochem., 30: 295-9(Aug. 1969).

Gamma irradiation and electric discharge, from a Tesla Coil, were used in the preparation of tritium-labeled proteins. Chromatographic analysis of tritium-labeled lysozyme prepared by either of the above methods revealed a strong similarity between the final products. The distribution of tritium among the amino acids of labeled lysozyme prepared by either method was also very similar. Because of the hazards and expense of γ irradiation, the electric discharge method for production of a free-radical population for tritium incorporation seems to be the most efficient. (E.R.B.)

43655 USE OF RADIOACTIVE ISOTOPES FOR EXPERIMENTAL INVESTIGATIONS IN AVIATION AND SPACE MEDICINE. Baranski, S. pp 185-205 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967.

The possibilities of using radioisotope tracer techniques to study the physiological effects of various stresses to which astronauts are subjected during space flight are discussed. Radioisotope tracer studies of the effects of centrifugation, temperature, hypoxia, vibration, and microwaves on metabolism and on function of the liver, kidneys, cardiovascular system, reticuloendothelial system, and hematopoietic system are reviewed. (C.H.)

43656 TAGGING OF SMALL ANIMALS WITH RADIOISOTOPES FOR TRACKING PURPOSES: A LITERATURE REVIEW. Gerrard, Martha (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop., 20: 671-6(Sept. 1969).

A review of the literature (36 references) shows that minute radioisotope sources attached externally to, or inserted subcutaneously in, small animals may be used for tracking purposes. (auth) (UK)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 43718, 43752, and 43893.

43657 (CEA-R-3848) A COMPARATIVE STUDY OF THE $^{90}Sr/Ca$ RATIO IN HUMAN DIET AND BONE TISSUE. Coulon, Rene; Madelmont, Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1969. 44p. (In French). Dep.

A comparative study of both the evolution of ^{90}Sr content in the bones of individuals of different ages for the period 1962 to 1967 as related to calcium, and the corresponding diets permitted establishment of the relation between food contribution and the resulting bone burden. The study is mainly devoted to the group of adults, for which a mathematical expression is proposed which allows for the exchangeable form of a skeletal calcium fraction turned over in less than a year from the dietary calcium and the

stabilized form constituting the larger part of bone tissue characterized by a slow turnover. Both the amount of the exchangeable fraction and the turnover rate of the stabilized fraction are determined for vertebrae and ribs. At birth, bone levels indicate that the calcium used for skeleton modeling during fetal life originates from both maternal diet and bone tissue and a value is given to their relative significance. There appears a good relation between bone levels in infants from 6 months to 1 year of age and their diets. The physiological parameters particular to this age are quantified. (auth)

43658 (FOA-4-4395) STUDIES ON PLANT ACCUMULATION OF FISSION PRODUCTS UNDER SWEDISH CONDITIONS. XI. UPTAKE OF ^{90}Sr BY DIFFERENT CROPS AS INFLUENCED BY LIMING AND SOIL TILLAGE OPERATIONS. Fredriksson, L.; Haak, E.; Eriksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). July 1969. 57p. Dep. CFSTI (U. S. Sales Only).

The effect and practical value under Swedish conditions of liming and various soil tillage operations to reduce the transport of strontium-90 from the soil through foodchains to man after heavy fallout were investigated in four micro plot field experiments carried on for seven years. In the experiments the effect of different soil management practices were simulated by placing strontium-90 at different depths in the soil profile. In two of the experiments the placement effect was studied at two levels of pH and base saturation. The placement effect was evident. The deeper strontium-90 was placed, the lower was the uptake by plants. However, the effect was modified by a number of soil conditions, and climatic factors such as amount and distribution of precipitation. The effect of liming on the uptake of strontium-90 was high for Ca-deficient soils but low for soils rich in Ca. Plant availability of strontium-90 deposited in the soil did not show any gradual reduction during the seven-year-long experimental period. Practical value of different methods for decreasing plant uptake of strontium-90 is discussed. (Sweden)

43659 (NYO-2182-11) BRAIN TUMOR LOCALIZATION WITH POSITRON-EMITTING ISOTOPES. McQueen, J. D. (Baltimore City Hospitals, Md.). [June 9, 1969]. Contract AT(30-1)-2182. 8p. Dep. CFSTI.

Protein metabolism in mouse liver was studied using ^{131}I-labeled albumin as a tracer and differential centrifugation for the isolation of protein fractions. The hydrolysis of ^{131}I-labeled albumin in mouse liver cells and the uptake of ^{131}I-albumin by brain tumor cells was studied in vitro. The influence of clearance from the blood stream on brain tumor uptake of ^{74}As-labeled arsono-poly-L-lysine and ^{131}I-labeled albumin was studied in mice. (C.H.)

43660 (ORO-1643-92) STUDIES IN IODINE METABOLISM. Progress Report, July 1968-July 1969. Van Middlesworth, L. (Tennessee Univ., Memphis. Dept. of Physiology and Biophysics). Contract AT(40-1)-1643. 68p. Dep. CFSTI.

The results to date of a comprehensive study of iodine metabolism are reported. The investigation is divided into seven separate studies including: ^{131}I release from normal and hyperplastic thyroids of adult and newborn rats following injection in utero; dynamics of thyroid hormone synthesis in hyperplastic thyroids; effects of thiocyanate on intensely stimulated thyroids of rats (high doses of thiocyanate increased quantities of thyroidal iodine and decreased fecal excretion of thyroxine); effects of hypothalamic lesions on iodine metabolism in rats with hyperplastic thyroids; use of specific iodide electrodes in urine and saliva of rats; studies on thyroxine absorption from the intestine (a substance that binds thyroxine was identified in the bile of humans and rats); and data on the world wide monitoring of ^{131}I fallout in thyroids of sheep. In an additional section on collaberative studies with other laboratories, interest centered around the examination of slides of human thyroid tissues for evidence of calcium oxalate crystals in the tissues. A section is also included that contains reprints of articles published during the reporting year. (E.R.B.)

43661 (UCLA-12-731) INFLUENCE OF SOIL HEATING ON THE GROWTH AND ELEMENTAL COMPOSITION OF BEAN PLANTS. Nishita, H.; Haug, R. M.; Hamilton, M.; Alexander, G. V. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [nd]. Contract AT-04-1-GEN-12. 31p. Dep. CFSTI.

Experiments were conducted to study the effect of soil heating on the soil properties and the growth and elemental composition of bean plants (Phaseolus vulgaris). The plants were grown in soils exposed to various amounts of dry heat from ambient temperature up through 1,000°C. The following soil properties were examined: weight loss, particle size distribution, pH, organic matter content, total N content, cation exchange capacity, electrical conductivity of saturation extract, and NH_4OAc extractable cations (^{90}Sr, stable Sr, ^{137}Cs, Ca, Mg, Ba, K, and Na). The plant leaves were analyzed for the two radionuclides (^{90}Sr and ^{137}Cs) and 19 stable nuclides (K, Na, Mg, Ba, Ca, Sr, Fe, Cu, Al, Ni, Zn, Cr, Mn, Ti, Mo, Si, B, P, and Co). Plant growth was reduced markedly by soil heating, particularly at higher temperatures. The elemental composition of the plant leaves indicated that plant yields were conditioned by a combination of decrease of certain essential nutrient elements and the increase of other essential nutrient and non-essential elements to toxic levels. (auth)

43662 (UH-235-P-8-11) PROGRESS REPORT [ON BIOMEDICAL RESEARCH], SEPTEMBER 1, 1968-AUGUST 31, 1969. Casarett, Louis J. (Hawaii Univ., Honolulu. School of Medicine). May 15, 1969. Contract AT(04-3)-235. 20p. Dep. CFSTI. Includes Reprints.

Research progress during 1968 and 1969 is reported for studies on the locus of deposition and redistribution of aerosol particles (using radioisotope-labeled particles) in the tissues of rats; the kinetic and physiological response of the pulmonary phagocytic system (peritoneal macrophages and alveolar macrophages); and the physiological responses that relate to or influence the deposition or retention patterns of inhaled materials that might be an etiologic stage in the development of pulmonary pathology from inhaled radioactive material. Primarily, the research year was devoted to establishing a well-equipped and functional laboratory for this type of research. (C.O.)

43663 WHOLE BODY AUTORADIOGRAPHIC STUDIES ON THE DISTRIBUTION OF RADIOISOTOPES. XIV. DISTRIBUTION OF A NON-NARCOTIC CENTRAL ANTITUSSIVE AGENT, 3-(1-METHYL)-1-PIPERIDIDENE-DI-(2'-THIENYL)-METHANE (AV) IN MICE. Sakuma, Mari; Sato, Yoshishige (Tanabe Seiyaku Co., Ltd., Kawagishi, Japan). Radioisotopes (Tokyo), 17: 441-8(Sept. 1968). (In Japanese).

The distribution of ^{3}H- or ^{14}C-labeled antitussive agent (AV) was studied by whole-body autoradiography in mice. The labeled AV was administered to mice by intraperitoneal, intravenous, subcutaneous, and oral routes and each distribution pattern was discussed. In any administration route, AV and its metabolites accumulated in the liver, kidney, lung, brown fat, salivary gland, harderian gland, gall bladder, gastrointestinal tract, and urinary bladder. This compound also accumulated in brain at first after intravenous injection and was easily absorbed from the digestive tracts. Almost all of the AV and its metabolites were excreted in urine and feces within 24 hr after administration and retention of radioactivity was not observed in any tissue. The radioactive substances passed the placental barrier but radioactivity in fetuses was lower than that in maternal tissues. (auth)

43664 ^{137}Cs METABOLISM IN MAN. Ramzaev, P. V.; Troitskaya, M. N.; Ibatullin, M. S. (Leningrad Scientific-Research Inst. of Radiation Protection). Med. Radiol., 14: No. 8, 44-9 (Aug. 1969). (In Russian).

Cesium-137 metabolism was studied in 142 adult men of Northern regions in relation to water-salt balance and seasonal prevalence. In 95% of cases the following values were obtained: the semiexcretion period was 35 to 194 days (average, 82); absorption coefficient, 0.94 to 1.00 (average, 0.98); feces/urine ratio, 1.3 to 8.3 (average, 3.3). In winter the rate of exchange was twice as high as in summer. A quantitative assessment was made of the relation between cesium-137 metabolism and the main factors of the water-salt metabolism. (auth)

43665 RETENTION, EXCRETION, AND BLOOD CONCENTRATION OF ^{137}Cs BY RAT AS INFLUENCED BY STARVATION. Fujita, Minoru; Takata, Kazuo; Iwamoto, Junko; Kondo, Michio (Japan Atomic Energy Research Inst., Tokai). J. Radiat. Res., 9: 129-34(Sept.-Dec. 1968).

A single dose of ^{137}Cs was administered intraperitoneally to rats. The effects of starvation on the whole body retention, daily excretion and blood concentration were studied. During starvation, the urinary and fecal excretion of ^{137}Cs were low, and the biological half-life in the whole body was about three times as long as that of the control. The daily urinary excretion changed very quickly with the change of dietary conditions from feeding to starvation and from starvation to feeding. From the data on the urinary excretion and plasma concentration, it was calculated that the renal clearance during starvation was about one third of the control value. (auth)

43666 RADIOIODINE METABOLISM IN THE BEAGLE DOG: THE IMPORTANCE OF AGE AND MODE OF ^{131}I EXPOSURE. Foreman, Robert E.; Boecker, Bruce B. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Proc. Soc. Exp. Biol. Med., 131: 980-5(July 1969).

Seven parameters associated with ^{131}I whole-body retention and thyroid uptake-retention were chosen to characterize iodine metabolism in the beagle. No statistically significant differences in these parameters were observed in groups of beagle dogs ranging in age from six to 48 months. The 6-month-old dogs may have been too old to demonstrate a period of elevated thyroid function such as that reported for several other species. The influence of the mode of administration of ^{131}I on the resulting iodine metabolism was also investigated. Exposure of 18-month-old dogs to ^{131}I by the oral, inhalation, or intravenous injection routes produced no statistically significant differences in ^{131}I metabolism, probably because of extremely short pulmonary retention times and the solubility of the iodide ion in body fluids. Absorbed doses to the thyroid for dogs in this investigation ranged between 130 and 1700 rads. When these dogs were expressed as rads per microcurie of initial body burden, an analysis of variance showed that similar thyroid doses per microcurie administered were experienced by all dogs in the experiment regardless of age or route of ^{131}I exposure. The average dose administered was 5.8 rads/μCi. (auth)

43667 DISTRIBUTION OF NATURALLY OCCURRING RADIONUCLIDES BELONGING TO URANIUM DECAY SERIES. 2. CONTENT OF ^{210}Pb, AND ^{226}Ra IN THE HUMAN TOOTH MEASURED ON RESIDENTS IN AN AREA WITH RELATIVELY HIGH RADIOACTIVITY. Kuroda, T. Igaku To Seibutsugaku, 75: 230-3(Dec. 10, 1967). (In Japanese).

The border between Tottori and Okayama Prefectures, particularly in the neighborhood of Miasa, includes several uranium mines and a belt of hot springs with a high radium content. It was expected that the residents were exposed to a relatively high natural radioactivity, it was reported that mine workers were exposed to as much as 0.03 to 1.85 mR/hr. The ^{210}Pb and ^{226}Ra content of the teeth of the residents was compared with the corresponding data of inhabitants from Okayama City. The samples were classified according to age, sex, residence history, occupation, and date of extraction, listing also data on the location and type of tooth, type of decay, treatment, and smoking record. The analytical results are presented in two tables and broken down into different age groups and sex, comparing the residents of Miasa and Okayama City and listing similar data from other parts of the world. (TTT)

43668 DISTRIBUTION OF NATURALLY OCCURRING RADIONUCLIDES BELONGING TO URANIUM DECAY SERIES. 1. CONTENT OF ^{210}Pb AND ^{226}Ra IN THE HUMAN TOOTH AND THEIR MEASUREMENT. Kuroda, T. (Tokushima Univ., Japan). Igaku To Seibutsugaku, 75: 225-9(Dec. 10, 1967). (In Japanese).

The effect of small amounts of natural radiation on humans may be studied on people who live in areas with naturally high radioactivity background, mainly due to variations in the cosmic radiation received at various geographic locations. Direct measurement of natural radioactivity of the uranium-series nuclides was made on the bones of humans. The ^{210}Pb and ^{226}Ra content of teeth was taken as an indicator of the distribution of these nuclides. The tooth samples were cleaned, washed, air-dried, and dissolved in concentrated HCl. The Po in the diluted solution was plated on a silver disc in the presence of ascorbic acid and counted on a 2π gas flow counter for 8 to 16 hours. The effect of temperature, plating time, and HCl concentration on the Po recovery are discussed. To the filtrate from the Po separation were added 4 ml 4.24 M $Pb(NO_3)_2$ and 4 ml 0.018 M $Ba(NO_3)_2$, the mixture was heated, and 40 ml 9 M H_2SO_4 was added. After further treatment, the $Ra^{226}SO_4$ was precipitated together with $BaSO_4$, expelling the Rn before counting the Ra with a low background 2π gas flow counter. The radionuclide contents are discussed with respect to different parameters. (TTT)

43669 URINARY LEVELS AND EVALUATION OF THE DOSES OF FALLOUT ^{137}Cs IN RELATION TO PREGNANCY. Orlando, G. (Univ., Geneva); De Marini, M. G. Ig. Med. Prev., 8: 81-90(Jan.-Mar. 1967). (In Italian).

Investigations were made on the ingestion, excretion, and accumulation of fallout ^{137}Cs in two groups of women, one group consisting of pregnant women. It was observed that urinary excretion varied significantly between the two groups and that the body burden was always below the maximum permissible level recommended by ICRP. The corresponding values for K were also studied and they were compared with those for ^{137}Cs. (auth)

43670 THE INORGANIC AND ORGANIC PHASE OF THYROID UPTAKE OF RADIOIODINE IN THYROTOXICOSIS TREATED WITH SYNTHETIC ANTITHYROID AGENTS. Valentini, F.; Lodeserto, A.; Reschini, E.; Vivarelli, S.; Miedico, D. (Univ., Milan). Folia Endocrinol. (Pisa), 21: 385-95(July-Aug. 1968). (In Italian).

Radioiodine metabolism was studied in 31 hyperthyroid patients being treated with methylmercaptoimidazole (40 mg/day at first, decreased later to 10 to 20 mg/day) or carbethoxymethimazole (80 mg/day, reduced to 20 to 40 mg/day). The thyroid radioiodine uptake was measured after 2 to 20 min and 6 to 24 hr to ascertain whether a long-term treatment with these antithyroid drugs influences organic and also inorganic thyroid uptake. It was observed that early thyroid uptake values decreased, as well as late uptake values, during long-term treatment with the usual therapeutic doses of the antithyroid drugs. There was no correlation between the doses of the drug and the decrease of inorganic and organic radioiodine uptake values. The different susceptibility to the drug in each patient is cited as a reason for these findings. Values of the early and late radioiodine uptake in patients during antithyroid therapy do not allow identification of the relapse prone patients from those who do not relapse after drug withdrawal. (BBB)

43671 THE DISTRIBUTION OF ^{65}Zn IN MICE BRAIN. II. THE EFFECT OF SUBTOTAL PANCREATECTOMY ON ^{65}Zn DISTRIBUTION IN TISSUES, WITH SPECIAL REFERENCE TO CHANGES IN THE BRAIN. Fujii, Masataka (Yamaguchi Univ., Ube, Japan). Bull. Yamaguchi Med. Sch., 14: 105-13(Mar. 1967).

The effect of subtotal pancreatectomy on the distribution of ^{65}Zn in the brain was studied in mice of the dd strain. The body retention of ^{65}Zn was lower in pancreatectomized mice than in control mice at the later intervals (48 and 240 hr) following gastric gavage of ^{65}Zn. The ^{65}Zn activity in the brain showed a significant decrease at 48 hr following gastric gavage or subcutaneous injection. The relative ^{65}Zn activity in the hippocampus major showed a marked decrease at the late intervals (240 and 720 hr) following subcutaneous injection. The activity in other parts of brain did not show significant changes, except that the activity in the mesencephalon, pons, and medulla oblongata was slightly lower at 720 hr. These findings indicate that subtotal pancreatectomy affects particularly the ^{65}Zn concentration in hippocampus major. (BBB)

43672 UPTAKE OF RADIOACTIVE LEAD FOLLOWING INHALATION AND INJECTION. Booker, D. V.; Chamberlain, A. C.; Newton, D.; Stott, A. N. B. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Radiol., 42: 457-66 (June 1969).

Experiments have been made with human volunteers to determine the fate of ^{212}Pb (ThB) after inhalation. Two subjects inhaled the activity as a submicron aerosol and one also inhaled it as a vapor. The two subjects also received injections of ^{212}Pb in saline solution, so that the levels in blood following the two routes of entry could be compared. Measurements of the activity in excreta were also made. The activity was removed from the lung with a biological half-life of about ten hours. At 24 hours after inhalation about three-quarters of the particulate activity initially retained in the lung was found in the blood. The removal from blood to permanent sites of deposition and by excretion was comparatively slow. When a vapor of ^{212}Pb was inhaled, however, there was substantial fecal excretion (37 per cent of the retained dose in 72 hours). This is attributed to activity deposited on the ciliated epithelium of the upper respiratory tract and subsequently brought up and swallowed. (auth)

43673 MATERIALY PO TOKSIKOLOGII RADIOAKTIVNYKH VESHCHESTV SERA-35, KAL'TSII-45, FOSFOR-32. VYPUSK 6. (Materials on the Toxicology of Radioactive Matter (^{35}S, ^{45}Ca, ^{32}P). Number 6). Letavet, A. A. (ed.). Moscow, Izdatel'stvo Meditsina, 1968. 168p.

Eighteen articles are included on toxicology of ^{35}S, ^{45}Ca, and ^{32}P and their effects on animals. It was found that after a single injection of ^{35}S, the radioactivity decreased more slowly in the albumin of the brain and testicles than in other tissues. Sulfur-35 was more toxic after chronic treatments than after single administration of large doses. Alterations occurred in hematopoiesis, nucleic acid metabolism, and optic organs. After daily injections of ^{45}Ca, the equilibrium level in a skeleton is slower than in the case of $^{89-90}Sr$, and the influence on the morphology of blood and marrow was less pronounced. The phagocytic function of neutrophils was strongly affected by ^{45}Ca. Chronic treatments with comparably high doses of ^{45}Ca induced multiple osteosarcomas in the animals examined. The influence of the pituitary on the life span, peripheral blood, and the state of endocrine glands during acute ^{32}P-induced radiation sickness is discussed. (R.V.J.)

43674 THE INFLUENCE OF IONIZING RADIATION RADIOPROTECTORS ON THE COURSE OF METABOLIC REACTIONS IN VIVO. Novak, L. pp 213-18 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967.

The effects of exposure to whole-body doses of 300 or 500 R x radiation on the metabolism of amino acids, fatty acids, and carbohydrates in rats were studied. The results showed that irradiation caused a decrease in all metabolic processes throughout the entire organism. It was concluded that irradiation affected the activity of enzymes involved in glycolysis and respiration and this effect was manifested throughout the animal. (C.H.)

43675 EFFECT OF INORGANIC PHOSPHATE AND GLUCOSE ON ^{32}P UPTAKE IN NUCLEOTIDES AND RESPIRATION OF CALF-THYMUS NUCLEI. Dancheva, K. I. (Higher Medical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 341-3(1969).

Thymus nuclei were isolated in isotonic sucrose 0.003 M $MgCl_2$ and 0.050 M tris-HCl buffer (pH 7). Phosphorus-32 uptake in labile nucleotide phosphate was investigated. The consumption of oxygen by the incubated nuclei was recorded by the Warburg manometric technique. With 14.4 μg and 86.4 μg concentrations of inorganic phosphate in the incubation mixture the ^{32}P uptake in labile nucleotide phosphate was equal. The increase of inorganic phosphate after a certain level lead to a decrease of ^{32}P uptake in the labile nucleotide phosphate. The oxygen consumption by the thymus nuclei was very slight. (H.L.W.)

43676 RADIOACTIVE STRONTIUM AND ALGINIC ACID. Ichikawa, Ryushi (National Inst. of Radiological Sciences, Chiba, Japan). Kagaku To Seibutsu, 7: 208-11(Apr. 1969). (In Japanese).

The peculiar behavior of alginic acid has been the object of many studies, and it has been proved that the acid is effective in preventing the intake of radioactive strontium. Alginic acid is a constituent of seaweeds, being used widely as the Na salt. Strontium behaves very similarly to calcium, so that it is difficult to prevent the entry of only strontium, without preventing the intake of calcium. In this connection, the affinity of alginic acid to strontium, and the fact that it is absorbed as food indicate the effectiveness of alginic acid in preventing the intake of radioactive strontium. The peculiar behavior of alginic acid toward strontium and its applications are described in the following categories: strontium and calcium in the marine life; brown seaweeds and strontium and calcium; experiments with animals; and applications to the human body. (NSA of Japan)

43677 COMPARATIVE STUDIES OF THE ABSORPTION OF HEAVY METALS IN VIVO AND IN VITRO. Leopold, G.; Furukawa, E.; Forth, W.; Rummel, W. (Univ., Saarlandes/Homburg, Ger.). Arch. Pharmakol. Exp. Pathol., 263: 275-6(Apr. 1969). (In German).

Resorption of ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{203}Hg, ^{204}Tl, ^{113}Sn, ^{210}Pb, and ^{125}Sb through the jejunal and ileal mucosa was measured in vitro by everted intestinal sacs and by intestinal loops in vivo. Measurements were made 3 and 17 days after peroral administration of the radioisotopes. The in vivo resorptions of ^{59}Fe and ^{60}Co were higher in the jejunum than in the ileum, but the reverse was true for all of the other radioisotopes. In vitro the resorptions of ^{54}Mn and ^{125}Sb were higher in the jejunum than in the ileum. The only radioisotope that was resorbed in vitro more through the ileum than the jejunum was ^{51}Cr. In vivo ^{204}Tl had the highest resorption rate. It was twice that of ^{60}Co. The decreases in concentration of the radioisotopes in the animals over the period from 3 to 17 days after administration ranged from 2 to 92% in the decreasing order ^{113}Sn, ^{59}Fe, ^{125}Sb, ^{65}Zn, ^{203}Hg, ^{210}Pb, ^{60}Co, ^{54}Mn, ^{51}Cr, and ^{204}Tl. (BBB)

43678 THE APPLICATION OF WHOLE-BODY COUNTING TO STUDIES OF THE TURNOVER OF ^{131}I-LABELED PLASMA PROTEINS. Mouridsen, H. T.; Bojsen, J.; Fabier, M. (Finsen Inst., Copenhagen). Scand. J. Clin. Lab. Invest., 23: 379-85 (June 1969).

Use of whole-body counting in the study of the turnover of ^{131}I-labeled plasma proteins is described, and difficulties due to a change in count rate, attributed to the distance between the activity in the body and the detector decreasing when part of the tracer moves from the intravascular to the extravascular space, are overcome. Several conditions, primarily the counting geometry, but also the metabolic properties of the labeled protein, and the nutritional state of the person measured, may influence the size of this apparent change in counting efficiency. The detectors used are four 4 × 2 in. wide-angled crystals (NaI(Tl)), that are fixed to a bed-like chair in such a way that the detector response is little affected by the build of the person and the distribution of the radioisotope. The counting efficiency measured in the patients for the 364-keV γ radiation was 0.7%, corresponding to 12,700 cpm/μCi. Studies were carried out in order to evaluate the stability of the equipment. The importance of the geometrical position of the single detector was examined by studying the curves of retained radioactivity as obtained from each of the four detectors in the metabolic studies described. All countings were performed on the 6th day of a ^{131}I-albumin turnover study, when equilibrium was obtained between intravascular and extravascular space. From the results obtained it was concluded that the counting geometry used in this apparatus is able to compensate for shifts in tracer distribution during such studies. (BBB)

43679 COMPARATIVE METABOLISM OF ^{137}Cs BY ADULT, SUCKLING, AND PRENATAL RATS. Mahlum, D. D.; Sikov, M. R. (Battelle Memorial Inst., Richland, Wash.). Comp. Biochem. Physiol., 30: 169-75(July 1, 1969).

To determine whether ^{137}Cs freely crosses the placenta, 50 μCi of ^{137}Cs was injected intravenously on the 15th, 16th, or 19th day of gestation in pregnant female rats. Concentrations of ^{137}Cs in fetuses from dams injected at 15 or 19 days of gestation and sacrificed 24 hr later were similar to that of maternal blood, 0.08% dose/g. Lower concentrations were found in the fetuses when the dams were allowed to live until 4 days after injection. At 1 day postinjection, the concentration of ^{137}Cs in the amniotic fluid was about 1/5 of that in the intact fetus while the concentrations in the fetal blood were between those of fetus and amniotic fluid. The concentrations of ^{137}Cs in the individual fetal tissues were all less than in the comparable tissues of the dam. The ratios of the concentrations in the maternal tissues to that in the blood were all higher than one although the value of this ratio varied widely. These ratios (tissue/maternal blood) approximated one in the fetus and remained within a narrow range. The rate of loss of ^{137}Cs was initially lower in the early neonate than in the adult, but subsequently increased to a value much larger than for the adult. The relative distribution of the ^{137}Cs among various tissues changed with time after administration and differed significantly between the neonate and mature animal. (BBB)

43680 RADIOIODINE KINETICS IN FISCHER RATS WITH TRANSPLANTABLE THYROID TUMORS. Rotzsch, W.; Steinbach, R. (Karl-Marx-Univ., Leipzig). Rev. Roum. Biochim., 6: 57-64(1969). (In German).

Effects of carnitine, the γ-trimethylbetaine of β-hydroxybutyric acid on incorporation of ^{131}I by hormonally inactive Wollman-type thyroid tumors were studied. With tumors with a follicular-like structure, the ^{131}I thyroid uptake was increased as compared to normal thyroids. This was ascribed to inhibition of ^{131}I uptake in thyroid by the tumor. Similar results were observed with tumors that were completely undifferentiated. The ^{131}I incorporated by the tumors was far less than the amount of ^{131}I formed in thyroid, but the ^{131}I in tumor was relatively high as compared to the plasma concentrations of ^{131}I. It was concluded that the hormonally inactive tumors exerted a thyrostatic action on the thyroid concentration of ^{131}I. (BBB)

43681 THE CHANGING IODIDE-UPTAKE TEST. Stanbury, John B. New Engl. J. Med., 280: 1474-5(June 26, 1969).

Radioiodine uptake by the thyroid gland is discussed, particularly evidence that the uptake value is declining because of increasing use of iodine as a food additive. The uptake of radioiodide is reciprocally related to the average daily ingestion of iodide. When the mean daily intake falls below 50 μg of iodide per day, the ^{131}I uptake by the thyroid gland at 24 hr usually exceeds 60%. A high uptake of radioiodine might fail to distinguish between thyrotoxicosis and iodide deficiency in regions where iodide abundance in the earth's crust is low, and an expected elevation in the uptake of radioiodine characteristic of thyrotoxicosis might be masked in a district where a large amount of iodide is ingested each day because of local dietary peculiarities. Any ^{131}I uptake test must be interpreted against a background of the normal value for the community. In a program for giving iodide should it become necessary to reduce the uptake of radioiodide in the event of ^{131}I fallout from a nuclear accident or incident, it was found that 1 to 2 mg of added iodide daily effectively lowered the radioiodide uptake to negligible levels within 3 weeks. Withdrawal of the supplement was followed by a quick rebound toward pre-existing levels. Over a 10-yr period, a dramatic fall was noted in normal values for uptake of radioactive iodide, traced to a rise in intake of iodide, due to changes in methods for baking bread. Bread dough was found to contain iodide, in addition to calcium iodate, added as a stabilizer. (BBB)

43682 SELECTIVE UPTAKE OF ^{90}Y BY SPERMATOZOA FROM ^{90}Sr-^{90}Y EQUILIBRIUM MIXTURES. Coomes, Roger Kellogg. Ithaca, N. Y., Cornell Univ., 1968. 156p.

Thesis.

In order to study the ability of sperm to incorporate certain radionuclides, a technique was developed to measure nuclide uptake by rat spermatozoa in vitro. Approximately 10^7 sperm from the ductus deferens and/or cauda epididymis were incubated in 20 ml of a 50:50 mixture of Locke's solution and physiological saline

which contained 1 μCi/ml (total activity) of a $^{90}Sr-^{90}Y$ equilibrium mixture. One milliliter samples of the incubation solution were removed at selected intervals from 1 to 120 minutes; the contained sperm were deposited on Millipore filters, rinsed, and counted. Under these conditions, rat sperm incorporated an activity of 0.76 dpm per sperm with maximum uptake reached after 10 to 30 minutes of incubation. Half-life determinations and Feather analysis demonstrated that ^{90}Y accounted for 99.6% of the observed activity. For comparison, sperm were also incubated with other selected radionuclides. Much lower levels of ^{85}Sr or ^{45}Ca were incorporated by rat sperm; colloidal $^{59}FeCl_3$ was not incorporated to a detectable degree. Several studies were carried out to evaluate the yttrium binding capability, nature of the binding, and the form of yttrium (ionic or colloidal) that rat sperm incorporated. Sonication and differential centrifugation techniques showed that ^{90}Y was specifically taken up by sperm tails and not by sperm heads. Using carrier $^{89}YCl_3$, the maximum yttrium uptake was found to be 3×10^7 Y atoms per rat sperm. Once incorporated, yttrium was not readily removable from sperm by washing them with physiological solutions or distilled water. Removal could be rapidly accomplished with 1% citrate or with solutions having a pH below 2.5. Ultrafiltration of the $^{90}Sr-^{90}Y$ incubating solution with 100 Å pore-size Millipore filters or dialyzing with Visking cellulose dialysis membranes removed 50 to 85% of ^{90}Y from solution and greatly reduced radionuclide incorporation by rat sperm. It was concluded that radioyttrium in the colloidal form was incorporated by rat sperm. Rat erythrocytes and bull, rabbit, and guinea pig sperm were tested with $^{90}Sr-^{90}Y$ equilibrium mixtures. Guinea pig sperm incorporated the same amount of ^{90}Y as rat sperm; bull and rabbit sperm incorporated somewhat less. Sperm from all species tested incorporated greater relative concentrations of yttrium than did erythrocytes. The difference was greater than could be accounted for by surface area along and possibly reflects a fundamental difference in cellular surface characteristics. Rabbit sperm, treated with $^{90}Sr-^{90}Y$, were used to artificially inseminate Dutch-belted does. Ova were removed and cultured in vitro. Observations of development of ova fertilized by ^{90}Y treated and untreated sperm were made. No reduction in fertilizing capacity or detrimental effects for developing ova were observed that could be attributed to pre-treatment of sperm with ^{90}Y. (Diss. Abstr.)

43683 ROLE OF RADIOISOTOPES IN CLINICAL PHARMACOLOGY. **Dengler, H. J. (Justus Liebig-Univ., Giessen, Ger.). Arzneim.-Forsch., 19: 815-16(May 1969). (In German).**

Theoretical aspects of the use of radioactive labeled compounds in clinical pharmacology were reviewed. The major advantages of a radioactive label included extreme detectability, detectability even in unpurified materials such as plasma and urine, and the relative nonspecificity required to detect radioactive compounds. Methods of labeling chemicals nonspecifically or at definite locations in the molecule, methods of purification, radiolysis of labeled compounds, and methods to minimize radiolysis were discussed briefly. Problems of measurement of radioactively labeled compounds were discussed. Tests of stability of labeled compounds were listed briefly. Problems of dose level associated with limits of detection and pharmacology of labeled compounds, techniques of administration, and specific activity were discussed. Methods of radiochemical analysis, such as isotope dilution, preparation of radioisotopic derivatives, and double isotope derivatives, and double isotope derivative dilution procedures were discussed, and criteria for these were compared with other nonradioisotopic analytical methods. (BBB)

43684 ACCUMULATION AND TRANSFER OF RADIOSTRONTIUM BY YOUNG LOBLOLLY PINES. Dayton, Bruce Roy. Chapel Hill, N. C., Univ. of North Carolina, 1968. 70p. Thesis.

A study was conducted to quantify transfer and accumulation of radiostrontium by young loblolly pines on the Savannah River Plant, South Carolina. Stems of seven trees were each inoculated with 3 mCi of radiostrontium. Accumulation of radiostrontium in foliage continued for 13 months after inoculation, when a maximum of 1265 mCi per tree was attained. The prolonged period of accumulation in foliage was attributed to the influence of ion exchange on translocation and to the long life span of needles. The pattern of uptake and distribution in tree crowns was similar to that reported by other investigators for stable calcium in loblolly pines. There was little evidence of basipetal translocation of radiostrontium to roots. About 2% of the maximum foliage burden of radiostrontium was released by leaching during the 16 months of the study. Radioactivity of rainwater falling through crowns was best correlated with needle radioactivity, but was also inversely correlated with intensity of precipitation. Transfer of leached radiostrontium to the ground by rainwater flowing down stems was only 23% of that transferred by rainwater falling through tree crowns. Twenty percent of the maximum foliar uptake was released by needles falling from the trees. Most of this release occurred in the summer and autumn of 1967 when needles that were accumulating strontium since 1966 fell from the trees. The inoculated pines accumulated three times more radiostrontium in foliage than they released by needle fall and leaching. At the conclusion of the study, radiostrontium was distributed in the ecosystem in the following manner: 51% in stems and branches, 38% in needles, 10% in litter, and less than 1% in soil, roots, and understory. Ninety-four percent of the radiostrontium released from the inoculated trees was in litter. In 16 months only 4.6% of total radiostrontium released from foliage was transferred to mineral soil. Ground cover under the inoculated trees, primarily the litter, accumulated 20 times more radiostrontium than it released. Although much of the radiostrontium transferred to soil was confined to the top 2.5 cm where feeder roots are most abundant, less than 10% of the radionuclide accumulated in soil was in roots. Accumulation in soil and roots closely approximated input from needle fall and foliar leaching, indicating that release from roots of basipetally translocated radiostrontium was negligible. Little or no transfer out of the system by leaching to subsoil, runoff, or blowing away of litter was detected. In young pine stands, the increasing amount of litter added each year and the slow release to mineral soil would lead to a rapid accumulation of radiostrontium in litter and underlying organic matter. The radiostrontium burden of a pine forest contaminated by a pulse of radioactive fallout might be reduced considerably by removal of litter after peak needle fall. (Diss. Abstr.)

43685 IODINE POOLS IN EXTRATHYROIDAL TISSUES. **Costa, A.; Bacci, R.; Carli, M.; Cottino, F.; Listorto, G.; Magro, G.; Zoppetti, G. (Ospedale Mauriziano, Turin). Folia Endocrinol. (Pisa), 20: 284-9(May-June 1967).**

Distribution of radioiodine in various tissues and its excretion in urine were followed by use of ^{131}I in patients undergoing surgery and by ^{125}I in mice. Patients submitted to surgery for hernia, appendectomy, and endemic or sporadic simple goiter received a normal hospital diet (mean iodine content 70 to 80 μg per day) for about 10 days. N.M.R.I. strain mice, weighing about 15 g and receiving a normal diet, were used to study ^{125}I in muscle. Ten μCi of ^{125}I was injected into the peritoneum and the ratio between serum and muscle radioactivity was measured for 5 consecutive days. In both skeletal muscle and adipose tissue radioiodine content was greater in the goiter patients (~8 times and 4 times, respectively) than in the normal subject. This was often true for thyroid radioiodine content also. This series excluded hyperthyroid patients since such persons are normally subjected to various forms of treatment designed to change radioiodine metabolism before surgery. In mice, radioactivity concentrations were found to follow almost parallel patterns in homogenized muscle and plasma during the entire 5-day period of observation, but muscle gave distinctly lower values. Since muscle stable iodine values were 5 times those of plasma, the inverse sp act. ratio is striking. The slowly labeled peripheral pools may possibly contribute to the excretion of low sp act. iodine which is observable postoperatively. (BBB)

Radiation Effects

Refer also to abstracts 43372, 43654, 43733, 43849, 43907, and 43921.

43686 (ORO-3270-5) EFFECTS OF X-IRRADIATION ON ION FLUX IN NERVE MEMBRANES. Final Report. **Lott, James R. (North Texas State Univ., Denton). Aug. 14, 1968. Contract AT(40-1)-3270. 29p. Dep. CFSTI.**

Using two different methods, the effects of x irradiation on K, Ca, and Na flux from compound, desheathed toad sciatic nerves were studied. One method involved the use of flame photometry to measure ion flux from nerves that were soaked in Ringer's solution and then either x-irradiated or electrically stimulated or both. The second method was essentially the same, but a ^{42}K tracer was used. The following results were obtained from the study: x irradiation of compound nerves at dose rates found to alter electrical properties in compound nerves brought about a loss of ^{42}K from the fibers (in toto) within 5 min, electrical stimulation during the irradiation period prevented the radiation effect, and radioisotopes are superior to the flame photometric system for this type of study. In a parallel study, the effects of a specific stress (hypothalamic stimulation) were compared with that of a nonspecific stress (x irradiation) on the adrenal-pituitary response in rats. The results of this study to date were presented as follows: electrical stimulation of the hypothalamus resulted in a temporary but immediate rise in corticosteroid level; however, a sustained eosinopenia; x irradiation (940 R) brought about a sustained increase in corticosterone level plus a sustained increase in eosinophils; application of 940 R of x rays following electrical

stimulation of the hypothalamus (6 hr) resulted in a decrease in the corticosteroid response i.e., recovery occurred, whereas it potentiated eosinophil response (eosinopenia); hypothalamic stimulation during x irradiation resulted in a potentiated corticoid response, but not in the eosinophil response; the results indicate that ionizing radiation does affect the posterior hypothalamic and its influence in the adenohypophysis and that the changes in plasma corticosteroid, eosinophils adrenal weight following x irradiation may be in part mediated directly or indirectly by the hypothalamus; and finally, it is not possible to correlate completely the changes in eosinophil count with the plasma corticosterone levels in rats following either electrical stimulation or ionizing radiation. (E.R.B.)

43687 EFFECT OF X-IRRADIATION ON RNA SYNTHESIS DURING TRYPTOPHAN PYRROLASE INDUCTION IN RAT LIVER. Atsuta, Joe; Okajima, Shunzo (Nagasaki Univ.). J. Radiat. Res., 9: 135-40(Sept.-Dec. 1968).

The effect of x-irradiation on ^{32}P incorporation into both nuclear and cytoplasmic liver RNA of adrenalectomized rats treated with single or combined inducer, cortisone and L-tryptophan was studied. The single administration of tryptophan as that of cortisone increased the synthesis of nuclear RNA. The tryptophan-induced increase was significantly suppressed by 500 R whole-body x-irradiation, while the cortisone-induced RNA synthesis was not affected by irradiation. No x-ray-induced inhibition of the RNA synthesis was observed in the case of the combined administration of both cortisone and tryptophan, while combined administration of the inducers produced the most marked acceleration of RNA synthesis. When chromatographic patterns of specific activity of RNA prepared from irradiated animals were compared to those of unirradiated animals, it was found that the synthesis of RNA fractions eluted beyond the absorbancy peak of r-RNA was significantly suppressed by irradiation in the animals treated singly with tryptophan, and that this suppressed synthesis of RNA was not observed in the cortisone induction and was eliminated by the additional administration of cortisone to the tryptophan-treated animals. (auth)

43688 SOME ASPECTS OF METABOLISM OF CITRIC ACID IN CUSHING'S SYNDROME. Losana, O.; Messina, M.; Anselmo, G.; Tripodina, A. (Univ., Turin). Folia Endocrinol. (Rome), 21: 192-9(Apr. 1968). (In Italian).

The effect of ^{90}Y pituitary irradiation on some blood biochemistry values was studied in patients with Cushing's syndrome. Preirradiation fasting blood citric acid values were determined in 15 cases. In six of these cases, citric acid and creatinine clearances were also evaluated and the ratio was determined. Preirradiation blood citric acid values were fully comparable with those obtained in 24 controls, whereas the clearance and ratio values were significantly lower. All the tests were repeated after implantation of ^{90}Y in the pituitary in nine patients whose disease was of pituitary origin. Increased blood citric acid levels and normalization of clearance values were observed after radiotherapy. The blood citric acid concentration rose to 3.2 mg/100 ml compared with a pretreatment value of 2.1 mg/100 ml. (BBB)

43689 EFFECT OF ROENTGEN RADIATION ON THE BIOLOGICAL ACTIVITY OF ADRENALINE AND ACETYLCHOLINE. Danilenko, V. S. (Scientific Research Inst. of Pharmacology and Toxicology, Kiev). Farm. Zh., 23: 76-8(1968). (In Ukrainian).

The effect was studied of x irradiation of adrenaline (700 and 1500 R) and acetylcholine (1500 R) on the biological activity of these preparations. The index of the biological activity was the effect on the arterial pressure of cats. It was found that irradiation of adrenaline and acetylcholine did not change according to their hyper- and hypotensive effects. Thus, the properties of these drugs remained unchanged. (auth)

43690 SOME BIOPHYSICAL APPROACHES TO THE EFFECTS OF RADIATION AND THEIR REPAIR. Tobias, Cornelius A. (Univ. of California, Berkeley); Gopal-Ayengar, A. R. Advan. Biol. Med. Phys., 12: 215-8(1968).

A discussion of the mechanism of radiation damage and repair is presented. Two classes of radioinduced lesions of the DNA molecule are described. First are the point mutations caused by an alteration in the purine and pyrimidine bases. Secondly are abnormalities such as dimer formation, single-chain scission, double-chain scission, and cross-linking of DNA to nucleoprotein. These prevent normal reading or replication of the genetic message. Recovery of mice from x radiation, the dart recovery of diploid yeast cells, and the reversibility of uv radiation effects are mentioned. A summary of articles presented at the third International Congress of Biophysics in 1966 is also presented. (F.M.M.)

43691 CHANGES IN HYDROXYPROLINE CONTENT OF HUMAN DERMAL COLLAGEN FOLLOWING UV-IRRADIATION IN VITRO. Raab, W. P. (Vienna Univ. Medical School). Experientia, 25: 624(June 15, 1969).

Irradiation with uv light caused an increase in hydroxyproline content of acid soluble and neutral salt soluble collagen. Control experiments with uv-absorptive filters showed insignificant changes. The relative increase of hydroxyproline content was higher in acid soluble collagen (+50%) than in neutral salt soluble collagen (+40%). (auth)

43692 EFFECTS OF LOW DOSES OF X RADIATION ON MAMMALIAN CELLS EXPOSED IN VIVO. White, Stuart C.; Sobkowski, Frank J. (Univ. of California, Los Angeles). J. S. Calif. State Dent. Ass., 36: 434-6(Oct. 1968).

The cheek pouches of Chinese hamsters were exposed to 0.25 R and 5.4 R of x radiation. Thirty minutes later the animals were injected with vinblastine sulfate to arrest mitotic cells in the metaphase shape. A determination of the mitotic index showed no depression of mitotic activity from the low doses of x radiation. (F.M.M.)

43693 EFFECT OF X IRRADIATION ON THE MITOTIC CYCLE OF NK/LY ASCITES CELLS STUDIED BY LABELED MITOSES. Varga, L.; Varteresz, V. (Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Biochim. Biophys. (Budapest), 3: 217-25(1968).

Postirradiation changes in the generation cycle of Nemeth-Kellner lymphoma (NK/Ly) ascites cells as revealed by autoradiography with ^3H-thymidine are reported. Tumor cells (3×10^5) were injected intraperitoneally into mice. On the 6th day following implantation, the mice were given 500 R of x rays, then ^3H-thymidine at various times. The results showed that the immediate effect induced by x irradiation manifested itself in mitosis inhibition, lasting for 9 to 10 hr. After irradiation, the mitotic index dropped rapidly and 45 to 60 min afterwards the mitotic inhibition was complete. The pro- and metaphase cells disappeared first from the cell population and the ana- and telophase stage cells next. At later times dividing cells occurred only sporadically. Cells behind the G_2 block enter the M phase, while cells already in the M phase continue dividing and enter phase G_1. However, owing to the block of G_2, the replacement of dividing (M phase) cells stops, and as soon as the average M-period is over, the cell population no longer contains dividing forms. The actual cause of the G_2 block is not evident, and the mechanism acting at the cellular level, the lag or inhibition of which arrests the mitotic process, is unknown. Dividing forms appeared after the 9- to 10-hr mitotic inhibition and the mitotic rate displayed a slow rise. After 3 to 4 hr, counted from the restart of mitosis, the mitotic rate exceeded the control value. This was interpreted as the maximum mitotic frequency from the fact that the distribution of the total cell count changes among the various phases of the cell cycle. Accordingly, they accumulated in phase G_2, before the G_2 block. Hence, as soon as the inhibition stopped, more cells entered the M-phase, which increased the mitotic index. The altered distribution of cells, representing partial synchronization, manifested itself also in the change in the count of DNA synthesizing cells. (BBB)

43694 EFFECT OF FREE THYMIDINE AND DNA ON SURVIVAL OF IRRADIATED ANIMALS AND EXCRETION OF DEOXYURIDINE, THYMIDINE, AND β-AMINOISOBUTYRIC ACID. Mazurik, V. K.; Bryksina, L. E.; Podgorodnichenko, V. K. (Inst. of Medical Radiology, Obninsk, USSR). Biochemistry (USSR) (Engl. Transl.), 33: 774-9(Sept.-Oct. 1968).

Translated from Biokhimiya, 33: 953-60(Sept.-Oct. 1968).

Intraperitoneal injection of thymidine in rats in a dose of 5μmole per 100 g body weight on the sixth hr, or equimolar (with respect to thymidine) quantities of DNA on the 6, 24, or 48 hr, after whole-body irradiation in a dose of 800 R appreciably shortened the life span of animals. The excretion of deoxyuridine, thymidine, and β-aminoisobutyric acid (BAIBA) by control animals increased during the first 12 hr postirradiation. By the 48th hr postirradiation the excretion of deoxyuridine with urine dropped by 25 to 60%. The injection of thymidine into the animals on the 6th hr, or DNA on the 6, 24, or 48th hr, after whole-body γ irradiation in a dose of 800 R led to a depression of deoxyuridine excretion by a factor of 2 to 3, in comparison with the normal level beginning with the 24 to 48th hr postirradiation and lasting to the end of the experiment. The excretion of BAIBA in rats of these series increased again by a factor of 2.5 to 3 in comparison with the norm beginning with the 48th hr postirradiation. (auth)

43695 CHANGE IN THE TRANSPORT OF PROTEINS FROM THE MICROSOMES TO THE MITOCHONDRIA DURING ACUTE RADIATION SICKNESS. Galkin, A. P.; Piskareva, E. V.; Dya-

chenko, A. G.; Paskevich, I. F.; Todorov, I. N. (Inst. of Radiophysics and Radioelectronics, Kharkov). Biochemistry (USSR) (Engl. Transl.), 33: 796-806(Sept.-Oct. 1968).

Translated from Biokhimiya, 33: 981-92(Sept.-Oct. 1968).

The influence of whole-body irradiation on the transport of proteins from the microsomes to the mitochondria was investigated in vitro by the method of crossed systems (^{14}C-microsomes + cell sap + mitochondria) from the livers of control and irradiated rats. It was established that radiation suppression of the transport reaction is associated with peculiarities of the cell sap from irradiated animals, although radiation changes in the microsomes and mitochondria do participate somewhat in these disorders. The chromatographic separation of water- and phosphate-soluble proteins, ^{14}C-labeled in vivo, on DEAE-cellulose, as well as purification of the cytochrome c fraction (on DEAR-cellulose and CM-cellulose) from the liver and spleen mitochondria of control and irradiated rats, indicated a substantial decrease in the specific radioactivity of the proteins of these fractions over the entire chromatographic profile, and also, in particular, a decrease in the specific radioactivity on the profile of water-soluble proteins in the zone of hexokinase, DNAase, and RNAase, with a parallel decrease in the activity of the last two enzymes in the given fractions from irradiated animals. It is proposed that during irradiation, there is a disruption of the transport of a number of proteins in vivo from the microsomes to the mitochondria. (auth)

43696 EFFECT OF RADIATION ON THE CENTRAL NERVOUS SYSTEM. IX. VARIATIONS IN THE CONCENTRATION OF Na^+ AND K^+. Avellone, S.; Ortolani, E. A.; Zagami, M. T.; Rampolla, V. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 44: 1845-8(Nov. 30, 1968). (In Italian).

The concentration of Na^+ and K^+ in the cerebral cortex was determined in rabbits before and after exposure to a dose of 1000 R on the head. The irradiated animals were sacrificed eight hrs. after the irradiation. In the non-incubated cerebral cortex of unirradiated rabbits the quantity of Na^+ found was 0.055 mM/g of fresh tissue and that of K^+ was 0.079. In the non-incubated tissue of irradiated rabbits the values were 0.060 and 0.81 mM/g respectively. In incubated tissue the quantity of Na^+ and K^+ was always greater in the irradiated animals than in the non-irradiated animals. (J.S.R.)

43697 EFFECTS OF RADIATION ON THE CENTRAL NERVOUS SYSTEM. VIII. MODIFICATIONS OF THE CONTENT OF ACETYLCHOLINE. Avellone, S.; Ortolani, E. A.; Zagami, M. T. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 44: 1843-5(Nov. 30, 1968). (In Italian).

The effects of radiation on the acetylcholine content of the cerebral cortex, nuclei of the brain base, and cerebellum were investigated in rabbits exposed to a radiation dose of 1000 R on the head. The animals were sacrificed 1, 5, 8, 12, 24, and 48 hrs after the irradiation, and the acetylchloline content was determined and compared with that of unirradiated animals. The results are graphed and show that an hour after irradiation the acetylcholine content has increased in each of the three sections. The maximum increase is reached after 8 hrs. A statistical analysis showed that the increase at 8 hrs after irradiation is highly significant. (J.S.R.)

43698 SOME OBSERVATIONS ON THE EFFECTS OF IONIZING RADIATION ON THE METABOLISM OF DNA IN ANIMAL TISSUES. Stocken, L. A. (Oxford Univ.). Advan. Biol. Med. Phys., 12: 239-43(1968).

The role of DNA as a partner in the nucleoprotein complex is reviewed. It is pointed out that x radiation inhibits precursor uptake into DNA of many tissues of living animals. Irradiation either before or after partial hepatectomy delayed the onset of both the DNA synthetic period and mitosis. Investigations showed that there is an increased lability of hydrogen bonds in DNA after exposure to rather small doses of γ rays. This was shown by exchange of hydrogen for tritium in DNA previously equilibrated with tritiated water. Experiments were conducted to determine whether oxidized glutathione could act as a radiomimetic substance; it was shown that in certain nuclear functions the disulfide mimicked radiation damage. Investigations showed that changes in the thiol-disulfide balance led to oxidation of thiol groups in histones, and by the formation of disulfide bonds made links between two separate nucleohistone chains. (H.L.W.)

43699 FORMATION OF FREE RADICALS IN ALCOHOL EXPOSED TO ULTRAVIOLET AT 77°K AND PHOTOSENSITIZED WITH PURINES AND PYRIMIDINES. Golikov, V. P.; Zlatopol'skii, A. D.; Kalmanson, A. E. (Inst. of Virology, Moscow). Biophysics (USSR) (Engl. Transl.), 13: 939-47(1968).

Translated from Biofizika, 13: 801-8(1968).

In alcoholic solutions of the nitrogenous bases of DNA (NB) and their derivatives, uv irradiation at 240 to 400 mμ at 77°K resulted in the photosensitized formation of alcoholic free radicals. The value of the radical yield of the alcoholic radicals in solutions of purine NB was 30 to 100 times higher than in solutions of pyrimidine NB. Proof is given that in alcoholic solutions of NB two photons are required for the formation of alcoholic radicals. (auth)

43700 FREE RADICALS FORMED IN ALIPHATIC POLYAMINO ACIDS BY EXPOSURE TO HYDROGEN ATOMS. Liming, F. Glenn Jr. (Duke Univ., Durham, N. C.). Radiat. Res., 39: 252-76(Aug. 1969).

The free radicals formed in powdered samples of polyamino acids by exposure to thermal hydrogen atoms generated in a radio frequency discharge were identified by their electron spin resonance hyperfine patterns. Some of these radicals were also observed in γ radiation studies. Perhaps they were caused by reaction with secondary hydrogen atoms that were indirectly produced from the sample by ionizing radiation. The spectra presented in the present paper on polyamino acids with aliphatic side groups and in an earlier paper on polyamino acids with conjugated side groups provide a catalogue of spectra with which future spectra of hydrogen-bombarded proteins can be compared for analysis of the site of reaction of the protein with hydrogen atoms. Knowledge of the site of reaction of the hydrogen atoms with the polyamino acids has provided information about their primary and secondary structure. (auth)

43701 THE CONTENT OF SOME BLOOD SERUM LIPIDS IN PATIENTS WITH CANCER IN RADIUM THERAPY. Gasanov, A. S.; Tagi-Zade, S. B.; Guliev, F. G. (Research Inst. of Roentgenology, Radiology, and Oncology, Baku). Med. Radiol., 14: No. 6, 15-19(June 1969). (In Russian).

The influence of irradiation on alteration in the content of cholesterol, lecithin, and lipoproteins of the blood serum in 60 patients suffering from cancer of the esophagus, lungs, and uterine cervix was studied. Irrespective of the tumor localization during radium therapy there was a significant rise in the content of cholesterol, beta-lipoprotein fraction and a reduction in the level of lecithin and alpha-lipoprotein fraction. The degree of markedness of the changes directly depends on the value of the total exposure dose of irradiation. (auth)

43702 EFFECT OF SINGLE AND FRACTIONATED REPEATED ROENTGEN IRRADIATION OF SOME LIPID FRACTIONS IN RATS FED WITH NATURAL AND SYNTHETIC DIET. Nemec, R.; Laginova, V. (Onkologicky Vyskumny Ustav, Bratislava). Cesk. Gastroenterol. Vyz., 22: 463-72(Oct. 1968). (In Czech).

The effect of a single dose of chronically repeated x-ray irradiation with a total dose of 600 R on some lipid fractions of rats (cholesterol, phospholipid concentrations, esterified fatty acid serum and liver levels, iodine number in serum, liver, lungs and epididymal fat) were investigated. The rats were fed either a natural or a synthetic diet. The authors found that disorders of lipid metabolism were more marked in animals irradiated chronically with a whole-body dose of 100 R repeated six times than in animals irradiated with a single whole-body dose of 600 R. The most marked disorders were found in the level of the iodine number, smaller ones in the phospholipid and cholesterol levels. The changes in the esterified fatty acid levels were not marked. Disorders of lipid metabolism after irradiation were not appreciably influenced by the type of diet. (auth)

43703 BACTERIOPHAGE φX174 DEVELOPMENT AFTER γ-RAY, ULTRAVIOLET LIGHT, AND NITROUS ACID TREATMENT. Lytle, Carl David. University Park, Pa., Pennsylvania State Univ., 1968. 88p.

The steps in the growth cycle of a virus with single-stranded DNA at which inactivating damage is manifested were studied. The abilities of the bacteriophage φX174 inactivated by γ rays, uv light, and nitrous acid treatment to progress to different stages in the intracellular development were measured. The inactivation target for these agents is the DNA. The inactivation sensitivities were determined for the abilities of the phage to attach to the host bacterium, to inject its single-stranded DNA into the host, to permit the formation of RF molecules, to compete for transcription-replication sites, to prevent colony formation of the host bacterium, and to complement genetic functions. It was found that, for each inactivation means, all the abilities were affected except adsorption. In each case some inactivated phage could inject DNA that would be made into RF or RF-like structures. Whereas γ-ray inactivated phage could not express any phage specified functions, some uv-inactivated phage and some HNO_2-inactivated phage could. In the latter two cases less than half the inactivated phage could express functions. The uv-inactivated phage fared best at reaching the steps preceding transcription. The results indicated that the primary mechanism of inactivation was prevention, by the physical-

chemical lesions, of intracellular development leading to the expression of phage coded functions. There was suggestive evidence that the enzyme responsible for formation of the RF molecule from the single-stranded DNA could replicate past some uv damage but not past γ-ray or HNO_2 damage. This study indicated that φX174 system can be used to study the details of the effects of inactivating agents on DNA synthesis on single-stranded templates. A study was conducted to determine the frequency of backbone scission of the DNA relative to other lethal damage caused by the direct effect of γ rays. It was found that 26% of the γ irradiation lethality is the result of breaking the DNA ring. (Diss. Abstr.)

43704 PHOTOREACTIVATION SPECTRUM OF TOBACCO MOSAIC VIRUS RIBONUCLEIC ACID INACTIVATED BY ULTRAVIOLET RADIATION (2537 A). Hidalgo-Salvatierra, Oscar. Berkeley, Calif., Univ. of California, 1968. 120p.

Thesis.

The phenomenon of photoreactivation of tobacco mosaic virus ribonucleic acid was investigated in plants under light of different spectral quality. Techniques for the preparation of the virus and the virus RNA are described. The selection of the host for the assay of the nucleic acid was evaluated under different conditions. Pinto beans were selected over tobacco based on simplicity and reproducibility of results. Different photoreactivation techniques were investigated. It was concluded that the best way to carry out a photoreactivation experiment was to apply control and test solutions to the same plant, to inoculate several plants and keep half of them in the light and the other half in a dark room in an unconfined space. An action spectrum for photoreactivation and the optimum lighting conditions for photoreactivation kinetics were determined. Photoreactivation of irradiated (2537 Å) nucleic acid on pinto beans increased linearly with time of illumination with white light of 250 footcandles. Maximum amounts of photoreactivation depend on the spectral (i.e., variation of intensity with wavelength) quality of light used. The action spectrum showed two regions, one with a peak in the black light region (3000 to 4000 Å), where the greater amount of photoreactivation is found, and another represented by a shoulder in the blue light region. This spectrum was interpreted as representing two different photorepair systems acting on two different uv radiation produced lesions. Maximum repair was obtained with black light. Photoreactivation did not occur at wave lengths above 5500 Å. Photoprotection by illumination of leaves prior to inoculation with irradiated RNA was not found. The action spectrum for photoreactivation did not resemble the action spectrum for photosynthesis. (Diss. Abstr.)

43705 INTERPHASE DEATH OF CULTURED MAMMALIAN CELLS (L5178Y). Goldstein, R.; Okada, S. (Univ. of Rochester, N. Y.). Radiat. Res., 39: 361-73(Aug. 1969).

Mouse leukemic L5178Y cells in suspension culture were irradiated with large doses (6 to 200 KR) of x rays. Eosin staining, the criterion used for detection of dead or dying cells, increased around the time of increased leakage of ^{3}H-RNA, ^{3}H-proteins and ^{3}H-DNA from the cells, indicating that the eosin staining represents damage of cell membranes. Interphase death of cultured L5178Y cells was characterized by dose-dependent S-shaped curve of eosin staining, while reproductive death showed a somewhat dose-independent two-step curve. Judging from 50% eosin-staining time, the transition from reproductive death to interphase death is abrupt, suggesting a possible difference between the two types of killing mechanisms. From studies of the effects of various metabolic inhibitors on development of interphase death, we speculate that radiation-induced disorganization of the cells may be the cause of interphase death of rapidly dividing L5178Y cells in culture. (auth)

43706 EFFECT OF WHOLE-BODY X RADIATION ON THE METABOLISM OF ACID MUCOPOLYSACCHARIDES IN RATS. Glaubitt, Dieter (Univ., Hamburg). Strahlentherapie, 138: 105-14(July 1969). (In German).

The concentration of hyaluronic acid and chondroitic sulfate in different organs of the male Wistar rat was measured with column chromatography. The concentrations were markedly modified after irradiation when compared to controls. In the first day an increase of the acid mucopolysaccharides was observed in several organs, most of all in the rib cartilage, but a decrease in other organs. An explanation of this phenomenon is not possible up to now. (auth)

43707 IN VITRO STUDIES OF RADIOSENSITIVITY OF ALKALINE PHOSPHATASE IN LEUKOCYTES. Hartweg, Helmut; Renner, Karlheinz (Univ., Basel). Strahlentherapie, 138: 120-2 (July 1969). (In German).

Whereas the leukocyte alkaline phosphatases were increased in vivo after ionizing radiation, they were significantly decreased in vitro. The dose of 5000, 10,000, 25,000, and 50,000 R with conventional x rays, in one fraction was studied. The possible reason for this discrepancy is discussed. (auth)

Immunology

Refer also to abstracts 43847, 43848, and 43866.

43708 (NYO-2651-20) LOCALIZATION OF ANTIBODIES IN SPONTANEOUS AND INDUCED TUMORS. Progress Report, July 1, 1968-June 30, 1969. (New York State Dept. of Health, Albany). Contract AT(30-1)-2651. 23p. Dep. CFSTI.

The results obtained from a study of the effect of various factors including x radiation on the isoantigens available to circulating isoantibodies, indicated that the relative availability of isoantigens to purified circulating antibodies was constant under various physiological and pathological conditions. It was also found that isoantibodies isolated from multiparous C57BL/6 females (by DBA/2 males) exhibited in vivo localizing properties in DBA/2 mice. The studies have also shown an appreciable difference in the in vivo localization in brain and lung between the preparation of C57BL/6 isoantibodies produced against a DBA/2 leukemia and the preparation of C57BL/6 isoantibodies produced against nonmalignant lymphoid DBA/2 tissue. The former exhibited more localization in brain and lung. Another finding in the present study was that pretreatment of DBA/2 mice with ALS type antiserum (from rabbits) caused reduced uptake of isoantibodies in the liver. Studies of the localization of anti-lymphocytic antibodies in the brain indicated that antibody localization in brain following intravenous injection could be achieved without producing antibodies to brain tissue. This localization of antibodies in the brain is a rapid process followed by relatively rapid removal. Localization of antibodies in the circulation of mice bearing the Molony lymphoma was studied. Localization was demonstrated only in the spleen of the tumor-bearing animals. Another study dealt with the localization of mouse alloantibodies of known specificities. The results indicated that histocompatibility antigens of mouse tissues were exposed in vivo to humoral transplantation antibodies, and that antigenic tissues could readily fix such antibodies from the extracellular fluids. The fact that alloantibodies localize specifically in vivo offers the means of identifying cells by antigenic markers in recipients of allografts. (E.R.B.)

43709 (ORO-3853-85) ROLE OF THE RETICULOENDOTHELIAL SYSTEM IN RADIATION INJURY AND RECOVERY. Progress Report, July 1, 1968-June 1, 1969. Di Luzio, N. R. (Tulane Univ., New Orleans, La. Dept. of Physiology). Contract AT(40-1)-3853. 11p. Dep. CFSTI.

The reticuloendothelial system (RES) is a major system in the phenomena of immunology and transplantation, comprising as it does the afferent limb of the immune reflex arc. An appreciation of the mechanisms, both cellular and humoral, by which the RES possesses the ability to discriminate self from non-self, and the manner by which the RE cells are able to process particulate antigens and kill and digest foreign invading microorganisms should ultimately contribute to the advancement of health care and the development of new concepts in health and disease. Previous studies indicated that the phagocytic and immunological activities of the reticuloendothelial system could be markedly stimulated by the neutral polysaccharide glucan and profoundly impaired by the intravenous administration of an emulsion of methyl palmitate. Similarly, it was demonstrated that plasma factors or opsonins are vitally essential in the phagocytosis of a variety of colloidal particles by macrophage cells. The concept of the existence of a multiple opsonic system was proposed, since it was apparent that the opsonin for one particle was different from that opsonin required for the phagocytosis of other particles. These findings suggested that each particle or particulate antigen, on the basis of either its physical configuration, chemical reactive groupings, or its Zeta potential, or via a combination of all three, would react, when introduced into the vascular system, with specific plasma phagocytic promoting factors or opsonins that enhance the phagocytic removal of the particulate antigen. The system that was developed for the evaluation of opsonin activity involves the incubation of macrophage cells, namely Kupffer cells, in the presence of varying concentrations of plasma and the test particles under study. This system for the determination of opsonic activity was employed in experimental animals and in man to define the humoral aspects of phagocytosis. The development of this in vitro assay procedure for the evaluation of opsonic activity permits the definitive investigation of the nature of the phagocytic opsonin system. Studies to characterize, identify, and relate opsonin alterations to disease states are currently underway. The development of the opsonin assay procedure permitted the evaluation of the mechanism of the reticuloendothelial

blockade and recovery. Previously, a variety of mechanisms were proposed to explain the phagocytic depression observed following the administration of particulate materials. These included: physical saturation of phagocytic cells by ingested particles, a continuing circulation of the blockading agent that serves as a stabilizing agent for the injected colloid, a saturation of specific clones of phagocytes, and a depletion of available opsonins. Current studies demonstrated that the intravenous administration of our gelatinized reticuloendothelial test lipid emulsion induced a profound phagocytic depression as denoted by the impaired removal of the labeled emulsion from the vascular system. The impairment, that was associated with the exclusive decrease in liver phagocytosis, was temporary in nature and was followed by complete recovery in 3 hrs. The induced blockade was specific for the particle employed in that dissimilar particles were removed at normal clearance rates during the state of phagocytic depression, further supporting the concept of a multiple opsonic system. The injection of the gelatinized lipid emulsion in an opsonized state rather than its native unopsonized state, during a period of blockade, was associated with a complete elimination of the RE depressed state. In essence, these studies suggest that the reticuloendothelial cells have the ability to phagocytize additional particulate materials, if they are properly opsonized, during the presence of particle-induced blockade that is associated with the inability of the opsonin to complex with the injected particulate materials due to opsonin deficiency. Employing the opsonin assay technique, it was observed that a profound depression of opsonic activity occurred during a state of blockade. A restoration in opsonin levels during the post-blockade interval also occurred. Indeed, an excellent temporal relationship existed between reticuloendothelial blockade and subsequent recovery with the associated opsonin alterations. These studies also demonstrated there was obviously a physiological mechanism, as yet undefined, that controls the blood levels of opsonins and directly influences the activity of the cells that comprise the reticuloendothelial system. (auth)

43710 ALLERGIC ENCEPHALOMYELITIS: INHIBITION OF CELLULAR PASSIVE TRANSFER BY X-RADIATION. **Levine, Seymour; Prineas, John; Scheinberg, Labe C. (Bird S. Coler Hospital, Welfare Island, N. Y. Albert Einstein Coll. of Medicine, New York). Proc. Soc. Exp. Biol. Med., 131: 986-90(July 1969).**

Experimental allergic encephalomyelitis (EAE) was produced in rats by passive transfer of fully immunized lymph node cells into immunologically naive, isohistogenic recipients. Passive transfer of EAE was inhibited by x radiation of recipients shortly after or 24 hr before the transfer. Inhibition depended on the dose of radiation. It did not require direct effects of radiation on the encephalitogenic lymph node cells or on the brain, or indirect effects through the adrenal. Inhibition was associated with massive destruction of the recipient's lymphoid and hemopoietic systems, and may be related to deficient capacity for mounting an inflammatory reaction. (auth)

43711 DEVELOPMENT OF MOUSE BLASTOCYSTS UNDER THE KIDNEY CAPSULE OF IRRADIATED RATS. **Zeilmaker, G. H.; Timmermans, A. (Netherlands Cancer Inst., Amsterdam). Transplantation, 7: 437-9(May 1969).**

To test whether a possible host resistance played a role in the suppression of the development of mouse blastocysts in the rats, 19 three-month-old (R × U) F_1 rats received whole-body x radiation (600 R 250 kv, 8 ma, Thoreus filter No. 1, 41 R/min). The same day or 1 day later, two (020 × DBAF) F_2 or BALB/c mouse blastocysts were grafted under the kidney capsule. Development of the typical hemorrhagic masses (1 to 4 mm diameter) containing trophoblast cells, and in several instances, embryonic elements as well, was noticed in 16 of 19 rats 6 to 10 days later. It was suggested that outgrowth of ectopically transplanted blastocysts, which normally does not occur, was possible following suppression of the immunological reactivity of the host by irradiation. (C.O.)

43712 SKIN ALLOGRAFT SURVIVAL IN CALVES: INFLUENCE OF THYMECTOMY AND EXTRACORPOREAL IRRADIATION OF BLOOD. **Chanana, Arjun D.; Cronkite, Eugene P.; Joel, Darrell D.; Schiffer, Lewis M. (Brookhaven National Lab., Upton, N. Y.). Arch. Surg., 98: 803-5(June 1969).**

The influence of extracorporeal irradiation of blood (ECIB) and thymectomy on skin allograft survival was studied in calves and these results were compared to those obtained with ECIB alone. Fourteen Holstein calves were thymectomized at ages ranging from 56 to 205 days. Full thickness pinch auto- and allografts of skin were made, and semipermanent carotid artery-jugular vein shunts (A–V shunt) were formed of silicone rubber tubing and Teflon vessel tips. A 1000 Ci ^{60}Co and 4000 Ci ^{137}Cs γ-ray sources were used for ECIB. The influence of repetitive sessions of ECIB on blood leukocytes is described. The development of lymphocytopenia was the same in nonthymectomized and thymectomized calves. Skin allograft survival in 21 nontreated calves ranged from 8 to 11 days (mean 9 days). In nine calves receiving repetitive ECIB alone, the skin allografts survived from 10 to 20 days (mean 13 days). With thymectomized calves the skin allograft survival was 10 to 51 days (mean 15 days). Skin allografts in seven out of nine nonthymectomized ECIB-treated calves survived longer than in control calves (maximum survival time of 11 days). In thymectomized ECIB-treated calves, however, the skin allografts in seven out of 14 calves failed to survive beyond 11 days. With one exception the addition of thymectomy to ECIB resulted in the skin allograft survival shorter than in ECIB-treated calves. The skin allograft survival in one calf was 51 days, and the next best survival time was 19 days. It is concluded, that in the calf, as in the adult dog, the thymus is not essential for skin allograft rejection. Thymectomy as a part of immunosuppressive regime in clinical organ transplantation is of questionable value. (BBB)

43713 STUDIES ON THE RADIOSENSITIVE PHASE OF THE ANTIBODY RESPONSE IN RABBITS. II. RECOVERY AND THE SECONDARY RESPONSE. **Pribnow, James F.; Silverman, Myron S. (Naval Radiological Defense Lab., San Francisco). J. Immunol., 103: 276-81(Aug. 1969).**

Macrophages from whole-body x-irradiated donors recovered the ability to induce antibody formation in normal recipients. Recovery took place within approximately 27 days, regardless of whether cells were transferred to recipients 5 days or 20 days after irradiation of donors. Irradiated recipients of sensitized macrophages formed no antibody during the first 21 days after cell transfer. These rabbits responded to challenge with bovine gamma-globulin (BGG) with what appeared to be a typical secondary response. Recipients of irradiated sensitized cells (750 R) responded in a similar manner. When recipients of sensitized macrophages had received 750 R rather than 450 R, there was neither a primary nor a secondary response. (auth)

43714 X-RAY RESISTANT CELL REQUIRED FOR THE INDUCTION OF IN VITRO ANTIBODY FORMATION. **Roseman, Jeffrey (Univ. of Chicago). Science, 165: 1125-7(Sept. 12, 1969).**

Mouse spleen cells were separated into two populations on the basis of adherence to plastic. The recombination of these two populations was required for the in vitro antibody response to sheep erythrocytes. By separating the two populations from x-irradiated mice and combining each with the other population prepared from normal mice, it was demonstrated that the immunologic function of the non-adherent population only was highly sensitive to x-ray injury. In contrast, x irradiation in doses as high as 1000 R had no measurable effect on the immune function of adherent cells, that is, the population that first interacts with antigen and is composed principally of large phagocytic cells. (auth)

Ecology

Refer also to abstracts 43282, 43684, and 43752.

43715 (CEA-Bib-138) BIBLIOGRAPHIC DISCUSSION ON THE PHYSICO-CHEMICAL BEHAVIOR AND THE RADIOECOLOGY IN HYDROBIOLOGICAL SYSTEMS OF CERIUM AND OTHER LANTHANIDES. **Bittel, Robert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1969. 88p. (In French). (EUR-4107). Dep.**

The behavior of radionuclides characterized by a complex physico-chemistry and whose destiny in hydrobiological systems varies according to the combinations in which they are included is discussed. The first part is dedicated to the physico-chemical aspects. The main characteristics of rare earths are examined. A particular stress has been laid upon the lanthanides, certain isotopes of which are fission products with a long or medium half-life, and more particularly upon: cerium, promethium, and europium. The complexes of these elements with different mineral or organic compounds, present in effluents and contaminated aqueous environment, have been examined with a special regard to those complexes of great biochemical importance. Analytical techniques used in tracer chemistry and radiochemistry are described. The second part is dedicated to different aspects of the behavior of rare earths, principally of cerium in water and soils. It is obvious that the behavior of rare earths depends at one and the same time on the physico-chemical nature of the radioelement and on the environmental conditions. For the rare earths as for ruthenium and cobalt, previously examined, but perhaps to a lesser degree,

it seems frequently well-founded and desirable to substitute the idea of radioecology of a physico-chemical combination for that of radioecology of a radionuclide. (auth)

43716 (NP-17533) THE UPTAKE, MAXIMUM CONCENTRATION, AND LOSS OF SELECTED RADIONUCLIDES BY REPRESENTATIVE ORGANISMS IN THE ADRIATIC SEA. Annual Report, July 1, 1965-June 30, 1966. Keckes, Stjepan; Pucar, Zvonimir (Institut Rudjer Boskovic, Zagreb (Yugoslavia)). 287p. Dep.

Results are presented of studies on meteorological, physical, chemical, and biological conditions off the west Istrian coast. Radioecological investigations included analyses of sediments, sea water, and living organisms. Determinations were made on beta activity in marine organisms, and gamma spectrometry was used for analysis of organisms for ^{60}Co, ^{54}Mn, ^{106}Ru, ^{65}Zn, and ^{95}Zr. Physico-chemical studies were conducted on microconstituents in seawater. The uptake of $^{56,57,58}Co$, ^{54}Mn, and ^{65}Zn by marine mussels in the presence of EDTA was investigated. A study was made of metabolism of ^{22}Na in shrimps, mussels, and fishes during acclimation to various salinities. The metabolism of zinc in mussels was studied. Studies were made on biological transport of radionuclides, primarily fission products in representative marine organisms, and the inorganic microconstituents of seawater, with special attention to the effects of their physico-chemical state on their bioaccumulation. (H.L.W.)

43717 (UCLA-12-734) CHRONIC LOW-LEVEL GAMMA IRRADIATION OF A DESERT ECOSYSTEM FOR FIVE YEARS. French, N. R. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1969]. Contract AT(04-1)-Gen-12. 15p. (CONF-690907-1). Dep. CFSTI.

From Symposium on Radioecology, Aix-en-Provence, France.

Populations of vertebrate animals, certain insects, and plants were studied in three enclosed 8-hectare areas located in the Mojave desert. They were enclosed by a fence to prevent rodents from entering or leaving the study areas. One area was irradiated almost continuously at a dose rate of 80 to 500 mr/hr. Animal populations were examined by capturing, marking and releasing individuals. Plants were examined for growth and for production of leaves, flowers, fruit, and seeds. The life span of the population of pocket mice, Perognathus formosus, in the irradiated area was shorter than in the other areas. No difference was detected in the numbers of a small lizard, Uta stansburiana, that survived from year to year. Females of a larger but less numerous species of lizard have become sterile in the irradiated area. All vertebrate animals in the irradiated area have received exposures of 1 to 2 r/day. Certain species of plants have produced fewer flowers and fruits in the irradiated area. Plants have received exposures of 4 to 7 r/day. Although wild populations of small mammals are surprisingly sensitive to damage from chronic low-level radiation exposure, they are evidently able to persist under these conditions. There may be certain compensating mechanisms that become operative when the population is subjected to radiation stress. (auth)

43718 VOPROSY MORSKOI BIOLOGII. TEZISY II VSESOYUZNOGO SIMPOZIUMA MOLODYKH UCHENYKH, SEVASTOPOL, 1969. (Problems of Marine Biology. Reports of the Second Symposium of Young Scientists, Sevastopol, 1969). Kiev, Izdatel'stvo Naukova Dumka, 1969. 166p.

One hundred and twenty three abstracts of papers presented at the second symposium of young scientists are presented. Problems of marine biology are considered including; dietary conditions, morphology, reproduction, and migration. The physiological and biological factors influencing radioisotope migration and life time in marine waters are also considered. The uptake of ^{60}Co, ^{210}Po, ^{90}Sr, ^{90}Y, and ^{137}Cs by algae, phytoplankton, embryos of salmon, and other fish in marine waters is discussed as well as sonic signaling of peripheral structures of the nervous system. (E.R.B.)

43719 INFLUENCE OF SEASON ON THE RADIATION SENSITIVITY OF AN OLD FIELD COMMUNITY. Miller, Gary Lee. Chapel Hill, N. C., Univ. of North Carolina, 1968. 262p.

Thesis.

A study was conducted to quantify changes induced by seasonal exposure to ionizing radiation of an old field community on the Savannah River Plant. During each of four seasons, a two acre plot was exposed to 9200 Ci of ^{137}Cs for one month. This study confirmed predictions that radiation sensitivity is related to the season of treatment. The spring irradiation produced the greatest radiation damage, while the winter treatment produced the least. Radiation effects primarily involved a simplification of the community through a reduction of species density and diversity. Along a radiation gradient increasing from 17.4 kR (25 R/hr) to 208.8 kR (300 R/hr), a gradual depression of all species populations occurred to the point of complete elimination. This resulted in a reversion to an earlier successional stage that was typified by the replacement of dominant perennial grasses and longleaf pines with herbaceous annuals. Upon elimination or reduction of different species, the following vegetation zones developed. Areas exposed to 208.8 kR (300 R/hr) or greater experienced 100% mortality of the original vascular species, regardless of the season of exposure. The time required to produce total death, however, varied seasonally. Communities irradiated during the fall or winter required twice as long for death to occur as those exposed in the spring or summer. In a zone exposed to 34.8 kR (50 R/hr) to 208.8 kR (300 R/hr), changes occurred in density, diversity, growth, and biotic potential of the herbaceous species. The degree of change was directly dependent upon the relationship of the species' life cycles to the time of radiation exposure. Longleaf pine mortality was 100% and most dominant species underwent extensive reduction in density. Radiation exposures from 8.7 kR (12.5 R/hr) to 34.8 kR (50 R/hr) resulted in a slight reduction in density of herbaceous species, but no change in the dominants were observed. The greatest damage to herbaceous species was a reduction of growth and decreased biotic potential. Recovery in this zone was rapid. Pine mortality was 100%. In areas exposed to .17 kR (.25 R/hr) to 8.7 kR (12.5 R/hr) some longleaf pine survived, but apical and lateral buds suffered considerable mortality. The overall structure of the herbaceous stratum was unaffected. When one of the seasonal exposure periods coincided with a particularly sensitive phase in the life cycle of a species, slight reductions in growth and biotic potential were observable. Areas exposed to less than .17 kR (.25 R/hr) exhibited no changes in any of the characteristics measured. This study confirms that certain species are more sensitive to radiation than others. Longleaf pine exhibits at least a 200% greater sensitivity than the most sensitive herb during the most critical point in its life cycle. Within the herbaceous phase of the community, certain species are more sensitive than others. Much of the differential in radiosensitivity expressed by the herbaceous components can be directly related to the timing of the exposure in relation to the stages of the life cycle and/or specialized ecological or morphological features of the species. Radiation not only has direct effects on increased mortality and growth inhibition of species, but also it produces secondary effects in relation to disturbances of the environment that may lead to fluctuations in survival and success of a species after the stress is removed. These environmental changes often cause increases in population density, growth, and biotic potential of typically pioneer species. (Diss. Abstr.)

Genetics and Cytogenetics

Refer also to abstracts 43850 and 43916.

43720 (COO-1301-7) SOMATIC RECOMBINATION AND SEXUAL INCOMPATIBILITY IN SCHIZOPHYLLUM COMMUNE. Final Report. Ellingboe, Albert H. (Michigan State Univ., East Lansing). [May 31, 1969]. Contract AT(11-1)-1301. 8p. Dep. CFSTI.

Over 5,000 mutations to prototrophy were induced in auxotrophic strains of Schizophyllum commune in a search for selective genetic markers for use in detection of recombination events. From these no recessive suppressor mutations of six different loci were recovered when the inducing agents were x ray, ultraviolet radiation, ethyl methane sulfonate, or nitrous acid. However, recessive repressor mutations appeared to be induced by N-methyl-N'-nitro-N-nitrosoguanidine, acridine red, and hydroxylamine. These mutants were used for studying the transfer of incompatibility factor specificities in illegitimate dikaryotie-homokaryotic matings and for comparison of biochemical changes associated with compatible and noncompatible reactions. (M.M.B.)

43721 (COO-1400-25) INDUCED SOMATIC MUTATIONS FOR INTERPRETING FLORAL DEVELOPMENT AND INFLORESCENCE AGING. Mericle, L. W.; Mericle, R. P. (Michigan State Univ., East Lansing). [1969]. 12p. (CONF-690703-3). Dep. CFSTI.

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash.

Results of studies utilizing radioinduced mutations as ontogenetic time-clocks are presented. Single acute exposures of Tradescantia inflorescences to 25, 30, or 60 R 200 KVp x rays (at rate of 165 R/min) were used to induce somatic mutations at the delphinidin locus. Loss, inactivation, or mutation of this locus results in the production of "mutant" cells different in color from normal petal and stamen hair cells. Irradiation of different aged inflorescences was followed by daily scoring of mutant sectors. The mutation response and sector patterns were

dependent on the age of the inflorescence and the development of individual flowers. The effects of radioinduced aging on ontogeny are discussed. (M.M.B.)

43722 (EUR-4245) STUDIES ON CHROMOSOME ABERRATIONS OF LEUKOCYTES IN HUMANS EXPOSED TO RADIATION FOR MEDICAL PURPOSES. Final Report. Biagini, C.; Brancadoro, P.; Siciliano, A. (Rome Univ. (Italy). Istituto di Radiologia). Jan. 7, 1969. Contract 035-64-5-BIOI. 30p. Dep.

The research was performed in order to obtain quantitative data on chromosome aberrations of leukocytes, induced in patients bearing malignant tumors, by irradiation of a part of the body carried out for therapeutical purposes. No definite conclusions were reached on the possible influence of x-ray burden on the chromosome aberrations, based on the date of 32 subjects. The probability of obtaining positive cultures of lymphocytes in a group of 201 leukocyte cultures was related to erythrocyte sedimentation rate values, leukocyte counts and age. Data on chromosome aberrations collected on a group of 22 patients, 24–72 hours after a single dose of gamma rays, showed a continuous increase of the value of "breaks per abnormal cell" from 1.0 to 2.3 when skin doses are increasing from 25 to 1,200 Rad. In the same group the proportion of dicentrics and rings per cell is given by $y = 0.001 + 0.379 \times 10^{-14} D^2$, when D is expressed by g Rad as dose unit. The possible influence of the field size is discussed. In different groups of patients an increase of polyploid cells was observed in 72 hours cultures of leukocytes after irradiation of a part of the body from 1.16 tetraploid per thousand diploids in 25 samples of unirradiated subjects, to 2.6‰ in 20 patients irradiated on a chest field with skin doses ranging from 100 to 1,200 Rad, and 5.8‰ in a group of 5 patients after a full treatment of radiation therapy for cancer. (auth)

43723 (NYO-3096-27) PROGRESS REPORT FOR JUNE 1, 1968–MAY 31, 1969. No. 26. Dobzhansky, Theodosius (Rockefeller Univ., New York). Contract AT(30-1)-3096. 19p. Dep. CFSTI.

Experiments are described which showed that with strong selection for fitness, x-irradiated populations of Drosophila birchii became more efficient than unirradiated controls. Other experiments described include studies on the genetics of the coexistence of two species competing for limited resources, genetic homeostasis, frequency-dependent mating selection, selection for sexual isolation, and heterosis and the genetic structure of natural populations. (M.M.B.)

43724 INFLUENCE OF THE FERTILITY EPISOME ON THE SURVIVAL OF X-IRRADIATED ESCHERICHIA COLI. Axelrod, D. E.; Adler, H. I. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). J. Bacteriol., 98: 329-30 (Apr. 1969).

Evidence is presented that episome F, which controls fertility in Escherichia coli, influences sensitivity to the lethal effects of x radiation. Isogenic lines of Hfr (with episome F integrated into the chromosome), F^+ (with episome F not integrated), and F^- (without episome F) were tested for radiosensitivity. In each case the Hfr were more resistant than F^+ and F^-. The resistance of different donor Hfr strains was not dependent on the origin and direction of chromosome transfer. Transfer of the integrated episome by conjugation resulted in increased radioresistance in the recipient. Clumping, growth rate, colicin I, and bacteriophage λ were ruled out as explanations for the resistance of Hfr strains. (M.M.B.)

For abstracts of individual papers see: 43726 and 43727.

43725 NUCLEAR PHYSIOLOGY AND DIFFERENTIATION. Proceedings of an International Symposium held at Belo Horizonte, Minas Gerais, Brazil, December 1–6, 1968. Wagner, Robert P. (ed.). Austin, Texas, Genetics Society of America, 1969. 484p. (CONF-681215).

Published as a Supplement to Genetics, Volume 61, No. 1, 1969.

Separate abstracts were prepared for two of the 38 papers in this symposium. The papers are categorized into six groups dealing with; chromosomal activities during meiosis I, chromosomal activities during meiosis II, nuclear activities during development, DNA metabolism during development, genetic redundancy, and gene expression during differentiation. (E.R.B.)

43726 ORGANIZATION OF NORMAL CHROMOSOMES AND POST-IRRADIATION CHANGES IN MEIOTIC CELLS. Sotelo, J. Roberto; Wettstein, Rodolfo (Instituto de Investigacion de Ciencias Biologicas, Montevideo). pp 53-67 of Nuclear Physiology and Differentiation. Wagner, Robert P. (ed.). Austin, Texas, Genetics Society of America, 1969.

From International Symposium on Nuclear Physiology and Differentiation, Belo Horizonte, Brazil. See CONF-681215.

The organization of chromosomes at early meiotic prophase was studied using high resolution electronmicroscopy and serial sectioning. In high resolution pictures the basic elements found were filaments promedially 20 Å thick. In the axis of leptotene chromosomes, or in the lateral arms of synaptic ones (synaptonemal complexes), the path of these filaments was longitudinal, but it could deviate to either side of the main layer. In synaptonemal complexes, the filaments bending to the periphery integrated interwoven fibrils that blended in the surrounding nucleoplasm, while those bending toward the pairing space (bridges) formed the medial ribbon where elements from both sides intermix. In some species this followed a regular pattern. Serial sectioning and reconstruction of nuclei allowed the comparison of the number of synaptonemal complexes and the number of bivalents of the species, as well as allowing evaluation of other nuclear components similar to synaptonemal complexes. This method was used to study the effect of ionizing radiation on meiotic cells of Gryllus argentinus. Part of the results are reported as a preliminary note in this paper. Early substructural alterations of the chromatin of resting spermatogonia (fixed 2 hr after exposure to 1000R ^{60}Co are described as ringlets formed by accumulation of the chromatin basic components. Alterations of the spermatocyte components consisted of shrinking of the nuclear outline (festooned nuclear envelope), increase of density of the chromatin, and, in some experiments, disruption of synaptonemal complexes; in other experiments these alterations appeared as abnormal complexes (? or 3 per nucleus) formed of a synaptonemal-like complex and a cylindrical structure, the latter showing an internal component with the structure of medial ribbons. The young spermatids of most of the specimens examined presented deep infoldings of the nuclear envelope and/or amitotic strangulation of the nucleus (hour-glass shape) accompanied by the formation of a fragmoplast. (auth)

43727 EXPERIMENTAL STUDIES ON SPERMIOGENESIS IN DROSOPHILA. Meyer, Guenther F. (Max-Planck-Institut fuer Biologie, Tuebingen, Ger.). pp 79-92 of Nuclear Physiology and Differentiation. Wagner, Robert P. (ed.). Austin, Texas, Genetics Society of America, 1969.

From International Symposium on Nuclear Physiology and Differentiation, Belo Horizonte, Brazil. See CONF-681215.

Developmental aberrations appearing during spermiogenesis in partially Y-deficient males of Drosophila can be roughly classified into early and late effects on the process of spermatid differentiation. It appears that all structural components of sperm organelles seem to be present but frequently fail to be organized into ordered complexes of normal architecture. The Y chromosomal factors seem to control the coordination of the various synthetic and morphogenetic processes in spermatids leading to the formation of functional sperm without necessarily contributing structural information on the molecular level. Aberrations of the X/Y-deficient type are also found in X/Y males. This natural variability was increased further by application of various physical and chemical agents (including x irradiation), ligation experiments, and transplantations of gonads and imaginal discs. Most of the alterations induced in X/Y males are similar to those observed in Y-deficient males, including suppression of formation of the Y loops in spermatocytes. They may thus be considered as phenocopies of Y deficiencies. In some cases the formation of a new kind of organelle in spermatids not found in X/Y or Y-deficient testes was observed. The spermatid differentiation as a whole is a process that displays great variability and instability not only under natural but also under experimental conditions. The instability may be a result of the presence of phylogenetically primitive regulation mechanisms involved in the differentiation of the flagellate-like gametes in higher organisms. (auth)

43728 THE SIZE OF THE PHOTOSYNTHETIC UNIT AND ITS VARIABILITY. IV. ON THE RELATIONSHIP BETWEEN CO_2 FIXATION AND CHLOROPHYLL CONTENT OF A CHLORELLA MUTANT. Wild, A.; Egle, K. (Univ., Frankfirt am Main). Photosynthetica (Prague), 2: 253-60 (1968). (In German).

Photosynthesic rate in a uv-induced mutant of Chlorella pyrenoidosa (C-1.1.10.36) was determined and compared with that in the parent strain (C-1.1.10). The photosynthetic activity of the yellow uv mutant changes during the regreening of the cells. When the photosynthetic rate per dry weight was plotted against the chlorophyll content, a sigmoid curve was obtained. An attempt was made to explain the curve on the basis of the efficiency of excitation transfer in the photosynthetic unit. The photosynthetic unit found by Emerson and Arnold to correspond to 2000 to 2400 chlorophyll molecules per evolved molecule of oxygen or in terms of a one-quantum reaction center with 250 to 300 molecules is considered efficient in its complete form. The importance of the photosynthetic unit is discussed. The discrepancy between the absorption power of chlorophyll and the rate capacity of the

electron transport system is reduced or removed by the photosynthetic unit. (BBB)

43729 RADIATION AND POPULATION CYTOGENETICS. Med. J. Aust., 2: 1134-5(Dec. 21, 1968).

Aberrations produced in chromosomes by ionizing radiation are briefly reviewed. Breaks induced by radiation should be randomly distributed along the length of a chromosome and between different chromosomes. However, the distribution of consequent aberrations should be nonrandom if factors exist which preferentially favor the occurrence of restitution involving breaks produced at particular sites. It may be a matter of chance whether a stable or unstable type of aberration is produced. Unstable rearrangements include acentric fragments, dicentrics, and ring chromosomes. Stable rearrangements are those theoretically capable of being indefinitely reproduced at mitotic divisions. Studies of human beings exposed to radiation show that unstable cells disappear with time while the proportion of stable cells remains fairly constant. Cells exhibiting unstable chromosome configurations must be in their first division after radiation injury. Cells examined 10 yr after irradiation contain unstable aberrations. Rearrangements, detectable in mitotic cells, are relatively common in the ordinary population, in which the frequency of heterozygotes for such rearrangements is about 0.5%. (BBB)

43730 INDUCTION OF MUTATION BY HEAVY WATER (D_2O) IN A STREPTOMYCIN-DEPENDENT STRAIN OF PROTEUS MIRABILIS. Jung, K. (Institut fuer Stabile Isotope, Leipzig). Z. Allg. Mikrobiol., 8: 1-7(1968). (In German).

The effect of D_2O in inducing mutations of Proteus mirabilis from dependence on streptomycin to independency was studied. The lag phase of the organisms was prolonged in the D_2O culture media. There was no shift of the streptomycin optimum in the D_2O media, as compared to controls grown in H_2O media. The dependent strain was not absolutely resistant to the streptomycin. In D_2O cultures, increased back mutation to streptomycin independency was observed during the logarithmic and stationary growth phases. The fractions of prototrophic, auxotrophic, and streptomycin-sensitive mutants remained almost unchanged in the D_2O cultures, as compared to the spontaneous mutants. The growth of spontaneous and D_2O-induced mutants was inhibited in the same degree as the growth of the original organisms studied, and it was concluded that there was selection of the revertants caused by the D_2O, as compared to the nonmutated bacteria. (BBB)

43731 RELATIVE BIOLOGICAL EFFECTIVENESS OF 14.1-MeV NEUTRONS IN THE INDUCTION OF DOMINANT LETHAL MUTATIONS IN THE MOUSE. Tutikawa, Kiyosi (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 105-6(1967).

The effectiveness of fast neutrons was compared with that of x rays in the induction of dominant lethal mutations following irradiation of spermatozoa. The 14.1-MeV neutrons from the T(d,n)He reaction were used on 2- to 3-month-old male mice of the CBA strain given doses of 242.5 and 485 rad. Other males of the same strain were given doses of 222 or 445 rad of x rays (dose rate 47.5 R/min) for comparison of dominant lethality with that for neutrons. One day after irradiation each male was outcrossed to 2 adult females of the ICR stock. Those females becoming pregnant were autopsied on or about the 14th day of gestation, when number of corpora lutea, and of live and dead implants were recorded. The dominant lethality was estimated from the live embryo/corpus luteum ratio, the induced dominant lethality being given by 1 (ratio in irradiated series/ratio in control series). Comparison of fast-neutron and x-ray results was based on the early matings during the first week after irradiation. Using $-\log_e(1-P)$ as an estimate of the dominant lethal mutation rates per gamete induced by the 2 kinds of radiation, it was shown that the mutation frequency from neutrons is higher than that from x rays, and the dose-frequency curves form a linear relation. If the mutation rate of 445 rad of x rays is equated with that of 242.5 rad of neutron around the 50% level of dominant lethality, the results suggest that 14.1-MeV neutrons are about 1.8 times as effective as acute x rays for the induction of dominant lethal mutations in mouse spermatozoa. (BBB)

43732 THE EFFECT OF 5-BROMODEOXYURIDINE (BUDR) ON THE FREQUENCY OF 14-MeV FAST-NEUTRON-INDUCED MUTATIONS IN THE GONIAL CELLS OF THE SILKWORM. Murakami, Akio (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 103-4(1967).

Postirradiation treatment of silkworm spermatogonia with BUDR or 5-bromouracil (BU) increases the frequency of specific locus mutations by about two or three times at the maximum. This enhancing effect was assumed to be caused by an inhibition of the recovery process of premutational lesions. Whether the radiation lesions produced by higher LET (linear energy transfer) radiations could be modified by a similar treatment with these chemical agents was studied. The effect of BUDR treatment of 14-MeV fast-neutron-induced mutations was studied in gonial cells of the silkworm. BUDR was administered to newly hatched larvae of a wild type by feeding them on leaves supplemented with the chemical (20 mg per 1500 heads) immediately after 14-MeV neutron irradiation. Data on the mutagenicity of BUDR treatment alone were not clear. However, when it was combined with 14-MeV neutrons, mutation frequencies were slightly enhanced in spermatogonia, but no enhancing effect was observed with oögonia. In the former case the enhancing effect was higher at the re locus than at the pe locus. As to the enhancing effect of BUDR, neutron-induced mutations responded to a lesser extent than x-ray-induced mutations. This might have been due to the fact that neutron-induced pre-mutational damages are less responsive to repair than those produced by low LET radiation. (BBB)

43733 PROBLEMA MITOGENETICHESKOGO IZLUCHENIYA KAK ASPEKT MOLEKULYARNOI BIOLOGII. (The Problem of Mitogenic Radiation as an Aspect of Molecular Biology). Gurvich, A. A. Leningrad, Izdatel'stvo Meditsina Leningradskoe Otdelenie, 1968. 240p.

The main facts on mitogenetic radiation discovered by Professor A. G. Gurvitch in 1923 are discussed. A special chapter is devoted to the mechanism of radiation origination based on recombination of free radicals. The energy emanated from these reactions excites molecules of the substrate and is manifested in radiation with spectrums specific for the given matters. The subsequent chapters treat the biological significance of the radiation illustrated with different phenomena of physiologic and pathologic character. Mitogenetic radiation is an indispensable link in the chain of processes leading the cell to division, it precedes first phases of mitosis and can be registered in cells dividing synchronously in the form of a premitotic flash. So, the energetic role of photons of the mitogenetic radiation in the process of cellular division of normal and malignant tissues is very significant. The spectral analysis of the mitogenetic radiation is a delicate indicator of functional states of nervous and muscular systems, cardiac muscle included. The spectra characterize some structural and energetic parameters of the molecular substrate and help to understand the connection of labile molecular structures of the substrate with functional states. The monograph deals with A. G. Gurvitch's conception of the unbalanced ordered state of the molecular substrate specific for living systems. Considerable attention is paid to general biological ideas of A. G. Gurvitch leading to this conception and to the theory of biological field. These biological conceptions lead to the necessity of analysis of biological phenomena from the point of view of continuous combined interaction of different levels such as systematic, cellular, and molecular which is proved by different facts. So the problem of mitogenesis can be considered one of the principal directions of molecular biology. The state of excitation of nervous and muscular systems is analyzed from this point of view, while the structural states of molecular substrate are considered as the basis of regulation of metabolic processes. The book contains principal materials characterizing cancer extinguisher of mitogenetic radiation which example shows practical importance of theoretic and experimental researches of the mitogenetic problem. The book contains 51 tables and 35 pictures, the reference list contains 108 entries. (auth)

43734 RELATION BETWEEN SENSITIVITY TO KILLING AND MUTATION OBSERVED DURING A MITOTIC CYCLE OF SILKWORM CLEAVAGE NUCLEI. Murakami, Akio (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 102-3(1967).

Cyclic change in radiosensitivity to killing has been reported for early cleavage nuclei of the silkworm. The most sensitive phase within a cell cycle was found to be the metaphase/early telophase, whereas the least sensitive was the interphase. This suggested that dividing chromosomes are sensitive. The change in mutation response was studied in relation to the progress of the mitotic cycle during early cleavage. Materials used were eggs laid by ++/++ females mated with pe re/pe re males. These eggs were collected every 10 min and allowed to develop for a definite duration until they were irradiated. Eggs 170 min to 230 min old (after oviposition) were irradiated at 10-min intervals. The radiation dose of 1000 R was delivered in 1 min. Mutation frequencies were estimated by specific locus method using the pe and re genes, and lethality was also examined. The mitotic phase of the irradiated cells was determined cytologically. Mutations most frequently found were fractionals. The highest peak for embryonic killing was at 190-min age. In contrast, the highest mutation frequency was observed at 200-min age. Cyto-

logical observation indicated that the phase of maximum embryonic killing corresponded to metaphase/early telophase (or M + G_1) and the highest mutation response appeared at late telophase/early interphase (or G_1 + early S). The discrepancy between the peak stages for cell killing and for mutation response suggests that the mechanisms involved are different. Presumably the target or targets responsible for cell killing are chromosomes and those for mutation response are DNA strands. (BBB)

43735 STUDIES ON STRAIN DIFFERENCES IN RADIOSENSITIVITY IN THE SILKWORM. II. RELATION BETWEEN SENSITIVITY TO EMBRYONIC KILLING AND MUTABILITY. **Murakami, Akio; Tazima, Yataro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 100-2(1967).**

Some silkworm strains are more sensitive to radiation than others with regard to embryonic killing. An investigation was carried out to ascertain if sensitivity to mutation runs parallel to sensitivity to killing. The strains used were: (resistant) Kansen, Aojuku, and Hiko; (moderate) Sekko; and (sensitive) Ascoli and Kojiki. The mutability was measured by the specific locus method, using egg color markers. Doses of x rays were delivered at 250 R/min. Both spermatogonia and oögonia were irradiated in the larvae after hatching with 1000 R. The mutation rates were higher for spermatogonia than for oögonia in all strains studied. The mutation rate of a Chinese strain, Sekko, was extraordinarily high, although for embryonic killing it belonged to the moderate group. Except for Sekko, it was inferred that sensitive strains to embryonic killing are also sensitive to mutation in both sexes. The sensitivity of oöcytes and mature spermatozoa was tested after 1000- and 2000-R irradiation of newly emerged adults. Sensitive strains for embryonic killing, Ascoli and Kojiki, were also sensitive with respect to mutation. In experiments with mature spermatozoa, x-ray doses given were 3000 and 6000 R. No distinct correlation was found between radiosensitivity to embryonic killing and mutability. This finding is in sharp contrast to those described above for the three types of germ cells. The discrepancy might be due either to the lack of recovery of radiation damage or to a different repair system in mature spermatozoa. (BBB)

43736 REPAIR OF RADIATION-INDUCED PREMUTATIONAL DAMAGES REVEALED BY FRACTIONATED IRRADIATION OF SILKWORM SPERMATIDS. **Tazima, Yataro; Onimaru, Kimiharu (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 91-2(1967).**

The results of studies on dose-rate effects of radiation strongly suggest the existence of a mechanism of repair of premutational damages. A marked enhancing effect was observed with regard to mutation frequency after irradiation of silkworm spermatogonia with two split doses of 500 R + 500 R. The mechanism was revealed in a cytological study. After initial exposure the proportion of G_2 cells increased among the germ cell population and if the second exposure was given to those cells an enhancement in mutation response was the result. Accordingly, this cannot be regarded as due to true repair. To obtain conclusive evidence for the repair, fractionation experiments were carried out with spermatids. Silkworm spermatids appear most abundantly in full-grown larvae. A total dose of 1000 R was given to full-grown larvae in two fractions: 500 R + 500 R. Intervals between the two exposures were 0, 6 and 12 hr. Split-dose irradiation clearly reduced the induced mutation frequency in comparison with the same dose given singly. Similar experiments were carried out at V-4.5 (fifth instar day 4.5) and mid-pupal stage, but the results were less conclusive for both stages. Since irradiation of full-grown larvae almost completely excludes the risk of contamination with cells irradiated at other stages than spermatids, the observed reduction in mutation frequency can be regarded as the reflection of a repair of premutational damages produced by radiation. (BBB)

43737 MODIFICATION OF γ-RAY-INDUCED MUTATION FREQUENCIES IN THE SILKWORM BY POST-TREATMENT OF SPERMATIDS AND SPERMATOZOA WITH NITROGEN GAS. **Tazima, Yataro; Onimaru, Kimiharu (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 92-4(1967).**

Direct evidence of repair of premutational damage can be obtained by fractionated irradiation of spermatids. Other evidence was obtained from the comparison of the effects of postirradiation treatment between nitrogen and oxygen. Both spermatids and spermatozoa were studied. Irradiation of spermatids was performed when the larvae attained maturity and irradiation of spermatozoa was carried out after emergence. For the detection of mutation, the specific loci method was used by employing pe and re genes as markers. The effect of N_2 post-treatment was examined both for N_2 pretreated and nonpretreated cells. For N_2 pretreatment, the wild type males were placed in a nitrogen gas chamber 25 min before γ irradiation. In the nonpretreated group, irradiation of wild type males was carried out in air. The irradiated insects were divided into 2 groups: one was subjected to N_2 post-treatment for 25 or 30 min and the other to O_2 post-treatment for the same duration. Post-treatment with N_2 was in most cases mutagenically more effective than that with O_2 for spermatids irradiated under anaerobic condition. However, the effect was reversed when the spermatids were irradiated under aerobic condition. In contrast, N_2 post-treatment of spermatozoa resulted in a lower mutagenic effectiveness than O_2 post-treatment when the insects had been pretreated with N_2 and irradiated under N_2. These results agreed with those obtained for Drosophila and provide additional evidence of a repair of premutational damages. (BBB)

43738 MECHANISMS OF MUTATION INDUCTION BY MITOMYCIN-C IN THE SILKWORM. **Tazima, Yataro; Onimaru, Kimiharu (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 94-5(1967).**

In experiments of postirradiation treatment of silkworm spermatogonia with various metabolic inhibitors, it was observed that mitomycin-C enhanced markedly the mutagenic effect of γ rays. The enhancing effect was more pronounced when it was administered 12 hr after irradiation. Experiments were carried out to examine if mitomycin-C is mutagenically effective when given to mature spermatozoa. It was injected into wild type male pupae of the C108 strain 2 or 3 days before emergence. Injection of mitomycin-C resulted in a high incidence of mosaic mutations as well as whole-type recessive mutations. The most striking effect was the extraordinarily high incidence of mosaics. Their frequency was from 10 to 20 times as high as that of the whole type. Assuming that the incidence of mosaics was due to a single helix (of DNA) type mutation and that of whole type mutations to a simultaneous occurrence of 2 single helix type mutations at the same locus, the probability of the incidence of whole type mutations could have been expected to be the square of the probability of the mosaics. The observed frequency for the whole type was about one order higher than such expectation. This suggests that whole-type mutants were also produced by a single mutational event acting on a double helix of DNA. (BBB)

43739 CHANGES IN THE MUTATION RESPONSE OF POSTMEIOTIC SILKWORM GERM CELLS TO γ RAYS WITH PROGRESSING SPERMIOGENESIS. **Tazima, Yataro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 97-8(1967).**

Two types of mutations may occur in DNA according to the site of occurrence, i.e., those occurring in one of the double helices and those occurring in both helices. Identification of those two types may be possible if postmeiotic germ cells are irradiated. When mutants are obtained as mosaics they may be attributed to the single helix type, whereas mutants with whole-body recessive characters may correspond to the double-helix type mutation. In the silkworm irradiation of spermatozoa results in the production of a higher proportion of mosaics than when early spermatids are irradiated. To determine if mutation response varies according to progressing spermiogenesis, data were obtained at different stages of development of the insects. Although the extent of mutation response varies depending on the irradiated stage, the data could be compared for the ratio of mosaics to whole mutants. Calculated ratios of mosaics to whole mutants at each locus were plotted against the developmental stages. In the male, meiosis usually takes place at V-2 (instar V day 2), and thereafter the germ cells enter into the spermatid stage. When the larva attains maturity (Full G), completely formed spermatozoa appear in the testis and increase in number progressively thereafter until the mid-pupal stage. The incidence of mosaics in relation to whole mutation was very low before meiosis, reached unity around V-4.5, and then increased rapidly with progression of spermiogenesis. It was concluded that the site of mutation response becomes reduced in size with the progression of spermiogenesis. This change may be correlated with a decreasing facility to repair premutational damage. (BBB)

43740 PHYTOTRON CULTIVATION OF EARLY BARLEY MUTANTS. **Dormling, I.; Gustafsson, A. (Royal Coll. of Forestry, Stockholm). Theor. Appl. Genet., 39: 51-61(Apr. 28, 1969).**

Mari barley, a radioinduced mutant of Bonus barley, has a different photo- and thermoperiodic response compared to its parent variety. Mari is to a great extent photoperiodically insensitive, since it can form seed at photoperiods of 24, as well as 16 and 8 hr. Bonus barley, on the other hand, has a pronounced long-day reaction with no seed formation whatsoever at an 8-hour photoperiod. A study was made of the photo- and thermoperiodic reactions of some mutants with common ancestry but belonging to different

gene loci. Eight mutants arising from Bonus barley by the following radiation doses were examined: mat-a^8, induced by 20,000 R of x rays; a^{11}, chronic γ irradiation; a^{12}, by fast protons; mat-b^7 by 5500 R of x rays; b^{10}, by 10,000 R of x rays; b^{13}, by 540 rep of neutrons; mat-c^{16}, by 960 rep of neutrons; and c^{19}, by 400 rep of neutrons. These mutants have special phenotypical characteristics according to their locus derivation. The results indicated that photoperiodic insensitivity, with regard to ear formation and heading capacity, as well as kernel production, frequently occurs in connection with drastically early mutants in barley. Four out of the eight radioinduced mutants give pronounced insensitivity. Three of the four insensitive mutants represent locus a, one belongs to locus b. Of the two c-mutants none were insensitive; both pronounced long-day types. The mutants of the three gene loci analyzed can be distinguished phenotypically with regard to morphological as well as physiological properties, in the field as well as in phytotron cultivation. The c-mutants are especially characteristic. However, there also are clear differences in reaction between the allelic mutants of a locus. In fact, all eight mutants studied reacted differently. (BBB)

43741 BRACHYPHALANGY, AN ALLELE OF EXTRA-TOES IN THE MOUSE. Johnson, D. R. (Univ. Coll., London). Genet. Res., 13: 275-80 (June 1969).

Brachyphalangy which arose in a neutron-irradiated mouse was studied. The semi-dominant gene for extra toes (Xt) in the mouse produces polydactyly when heterozygous and a complex lethal syndrome when homozygous. Brachphalangy (Xt^{bph}) is an allele with a similar but distinct phenotype. Because of its similarity to Xt, tests for allelism and linkage were carried out in the neutron-induced mutant. Xt^{bph} is a semi-dominant gene with complete penetrance and a deficiency of homozygous abnormals at birth. There is no deficiency before birth; in fact, there is a significant excess at Xt^{bph}/Xt^{bph} for which there is no obvious explanation. It was shown that Xt and Xt^{bph} are manifestations of the same genetic locus. In view of the consistent differences in phenotype observed (namely morphology of the feet, an embryonic face bleb, regular involvement of the sternum in the heterozygote, exencephaly, and increased edema of the homozygote) it is suggested that they are distinct alleles, and that the symbol Xt^{bph} be adopted for brachyphalangy. It is concluded that brachyphalangy is an allele of extra toes in linkage group XIV of the mouse. The phenotypes of both heterozygote and homozygote are distinguishable from, but similar to, those of extra toes. (BBB)

43742 EFFECTS OF PRE-TREATMENT OF FEMALE DROSOPHILA MELANOGASTER WITH ACTINOMYCIN D ON THE FREQUENCY OF DOMINANT LETHALS INDUCED BY X RAYS IN MATURE SPERMATOZOA. Proust, Jacqueline (Faculte des Sciences, Orsay, France). Compt. Rend., Ser. D, 269: 86-8 (July 7, 1969). (In French).

Females were divided into two groups; one group was injected with a solution of Actinomycin D and the other (control) with Ringer's solution. One half of each group was mated with non-irradiated males, and one half with irradiated males. From the second to the fourth day after separation of males and females, the total number of eggs deposited were counted. The frequency of dominant lethals was determined from the percentage of unhatched eggs. The frequency of dominant lethals induced in mature sperm was increased when the females were pretreated with Actinomycin D. This effect can be attributed in part to inhibition by Actinomycin D of the processes of restoration present in the egg. (H.L.W.)

43743 EFFECTS OF ULTRAVIOLET IRRADIATION ON ZOOSPORES OF PHYTOPHTHORA INFESTANS. McKee, R. K. (Ministry of Agriculture, Belfast). Trans. Brit. Mycol. Soc., 52: 281-91 (Apr. 1969).

The effect of uv irradiation of Phytophthora infestans zoospores on germination, subsequent growth, infection ability, and on race specificity (virulence) was studied in relation to the hypersensitivity gene R_1 in the potato. For irradiation, the zoospores suspension was exposed at a distance of 15 cm from a Hanovia low-pressure mercury lamp, type 751/62. Irradiation reduced the zoospores' ability, in order of increasing sensitivity, to germinate, to infect, and to grow in culture. Irradiation had a delayed lethal effect in that spores that appeared to germinate normally failed to continue growth. The deleterious effect of irradiation was reduced by subsequent exposure to visible light. Inoculation of a differential host showed that the presence of a small proportion of virulent spores could be demonstrated in a mixture of virulent and avirulent spores. No mutants to Race I specificity were, however, detected among the 725,000 surviving Race 4 spores after uv irradiation. Factors that might impede detection of mutants are discussed. (BBB)

43744 DISTORTION HYPOTHESIS: AN ALTERNATIVE TO A LIMITED NUMBER OF SITES FOR RADIATION-INDUCED CHROMOSOME EXCHANGE. Savage, J. R. K.; Papworth, D. G. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). J. Theor. Biol., 22: 493-514 (Mar. 1969).

When 2 or more chromosome exchange events occur within a nucleus, there is a probability that a given chromosome arm will be involved more than once. Since an arm can never be observed at metaphase actually participating in more than one asymmetrical exchange, an increasing proportion of exchanges fails to be scored as the number of events (a function of radiation dose) rises. By sampling from a theoretical chromosome exchange population, the extent of the interactions between exchanges involving common arms, and their consequences, were investigated for Campelia zanonia. It is shown that the distortion introduced into the frequency of exchanges between nuclei by this process is sufficient to account for the form and magnitude of the observed binomial distributions of exchange. There is no need to invoke a limited number of sites for exchange. Distortion leads to modification and eventual saturation of the dose-response curve. Methods are given for deriving distortion coefficients, which enable the true yield of exchanges for a given radiation dose to be calculated. Interaction between exchanges leads to many configurational changes, so that what is observed seldom reflects what has actually taken place. Interaction also produces a marked nonrandom loss of centric rings leading to a spurious dicentric : centric ring ratio. The implications of these findings on some radiobiological problems are discussed. (auth)

43745 GENETIC EFFECTS OF CUMULATIVE SPERMATOGONIAL IRRADIATION IN RATS. Taylor, Benjamin Aylette. Madison, Wis., Univ. of Wisconsin, 1968. 134p.

Thesis.

An experiment with rats was conducted for the purpose of determining the effects of cumulative paternal x irradiation. The traits studied were litter size, sex ratio, the age at opening of the vagina, and body weights at 21, 42, and 69 days of age. Litter size and sex ratio were used to estimate the frequency of lethal mutations, while the other traits were assumed to reflect the effects of selectively neutral mutations. The rats used in this experiment originated in the highly inbred MI_4 line. The males of the base population were randomly divided into a control group that received no irradiation and an irradiated group that received a 450 R whole-body fractionated dose administered in 100 R, 150 R, and 200 R fractions at 10, 12, and 14 weeks of age, respectively. The sons of irradiated males were in turn treated and mated to unirradiated daughters of irradiated males in each generation for a total of nine generations of irradiation. The males were mated at 26 weeks of age. The sperm responsible for fertilization were believed to be descended from irradiated spermatogonia. The control and irradiated populations were continued by restricted random mating, the restriction being that the mated pair have no grandparents in common. In generation three, and thereafter, a part of the litters were the result of sib mating, permitting the expression of recessive mutations. The analysis of 14 generations of data shows significant effects of irradiation on litter size and sex ratio. From these changes the mutation ratio to dominant, sex-linked recessive, and autosomal recessive lethals were estimated. The data indicate that most lethals kill in the prenatal period. The frequency of recessive visible mutations was also increased in the irradiated line. The mutation rates to spontaneous and induced recessive visibles were estimated. The mutation rate estimates to lethal and visible mutations were found to be in close agreement with comparable estimates in mice. Significant effects of irradiation were also observed for age of vaginal opening and body weights. Analyses of the means, the within-litter variances, and the covariances between off-spring and parent, indicated that the average heterozygous effects of induced mutations were to increase body weights and decrease age at vaginal opening, while the average homozygous effects were to decrease body weights and to increase age at vaginal opening. Overdominance of induced mutations with respect to quantitative characters was therefore indicated. (Diss. Abstr.)

43746 BIOLOGICAL ACTION OF IONIZING RADIATION. Pollard, Ernest C. Amer. Sci., 57: 206-36 (Summer 1969).

The effects of ionizing radiation on the cell are reviewed and a hypothesis suggested for its mode of injurious action. Information obtained from the bacterium as a model system is summarized. Ionizing radiation inhibits DNA synthesis (not very sensitive); halts messenger RNA synthesis (sensitive); causes protein synthesis to decrease; causes degradation of DNA (moderately sensitive). These effects suggest that transcription is altered and that the mechanism in the cell for the recognition of its own DNA is influenced. The increase in the RNA components may produce a confusion in the operation of the polymerase which makes new

DNA to the extent that wrong bases are occasionally introduced into the DNA chain. Each time this occurs there is a strong likelihood of a mutation. While some chemical mutagens and one special case of radioactive decay always generate the same mutations, ionizing radiation generally shows no such behavior. Its character is more like the spontaneously developed mutations. A hypothesis for radiation action is proposed. It is supposed that ionizing radiation acts on an element of the transcription apparatus. It inactivates it by producing an alteration in its conformation subsequent to ionization. The normal process of temporary separation of the strands of the DNA, and the use of one strand to make messenger RNA, locally ceases, and as a result drastic changes take place. One such change may be that the DNA becomes detached from the transcription apparatus, perhaps also becomes broken, and no longer moves smoothly through its combination of transcription and synthetic stages. It may appear like foreign DNA, invoking the cell mechanisms for destruction of foreign DNA. They act to degrade the DNA at the damaged site. The cell then contains the components of degradation and of incomplete transcriptions so that base insertions are not wholly responsive to the templates, and mutations occur. (BBB)

Health Physics and Safety

Refer also to abstracts 43479, 43507, 43509, 43642, and 44195.

Radioactive Contamination and Decontamination

Refer also to abstracts 43506, 43508, 43605, 43660, 43716, and 43758.

43747 (BNWL-1135) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD, JANUARY-JUNE 1968. Wooldridge, C. B. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT-(45-1)-1830. 67p. Dep. CFSTI.

Surveillance of the Hanford environs during the first half of 1968 showed that measured concentrations of radioactive materials and radiation doses received by nearby population groups were well within the appropriate limits and that radioactive wastes were under sound and continuous control. The major source of low-level wastes released from the Hanford plant to the environment in the first half of 1968 continued to be reactor cooling water discharged to the Columbia River, and ^{32}P continued to be the radionuclide of Hanford origin that contributed the largest radiation dose to individuals who consistently ate sizable quantities of locally caught fish. The estimated intake of ^{32}P from 200 meals (40 kg) of Columbia River fish for the 12 months ending June 30, 1968, was about 9% of the Maximum Permissible Rate of Intake (with bone as the critical organ). This intake was somewhat less than the estimate for the 12 months of 1967. Doses from drinking water were estimated for the adult GI tract, whole body, and bone, and for the infant thyroid because, for Richland residents, water is the major source of radiation dose from Hanford releases. The estimated thyroid dose of 58 mRem for a typical Richland infant from drinking water during the 12 months ending June 30, 1968, was somewhat greater than during the calendar year 1967. However, estimated doses to the GI tract, whole body, and bone of the adult Richland resident were similar to or less than comparable 1967 doses from drinking water. (auth)

43748 (CEA-R-3810) INTERNAL DECONTAMINATION IN THE RAT OF A RADIOACTIVE ZIRCONIUM-NIOBIUM OXALATE. Rinaldi, Renaud; Gavend, Michel; Rinaldi, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1969. 12p. (In French). Dep.

A study in the rat of internal decontamination of a zirconium-95 niobium-95 oxalate injected by the intravenous and intratracheal routes made it possible to confirm the effectiveness of zirconium citrate which had been previously studied. In the treated animals, an increased urinary excretion and a clear decrease of the accumulation of radioisotopes in bone were noted. However, the effectiveness of zirconium citrate depends on the rapidity of intervention. (auth)

43749 (PHS-999-RH-36) EVALUATION OF RADIUM CONTAMINATION IN AIRCRAFT INSTRUMENT REPAIR FACILITIES. (Eberline Instrument Corp., Santa Fe, N. Mex. Bureau of Radiological Health, Rockville, Md.). May 1969. Contract 86-67-66. 37p. Public Health Service, Rockville, Md. Free.

Dial-stripping operations in aircraft instrument repair facilities have caused alpha-particle contamination levels exceeding 100,000 disintegrations per minute/100 cm^2 in these facilities, with up to 1,650,000 disintegrations per minute/100 cm^2 in one facility. Existing radium control programs in these facilities are inadequate. Instrumentation, training, and assistance for decontamination and waste disposal are needed in most of the facilities surveyed. Two workers in the facility with the highest levels of contamination had body burdens in excess of 40% of the maximum permissible body burden of radium, and a third worker had a possible body burden of about 14%. Workers in all other facilities included in the study had less than 10% of the maximum permissible body burden. A recommended control program for aircraft instrument repair facilities is described. Decontamination of one aircraft instrument repair facility was conducted to evaluate decontamination methods for floors, benches, and equipment. The final survey of the facility showed that alpha-particle contamination levels of floors and tables were generally below 2,500 disintegrations per minute/100 cm^2 fixed and 30 disintegrations per minute/100 cm^2 removable. The average decontamination factors achieved were 25 for floors, 100 for highly contaminated benches, and 15 for equipment. (auth)

43750 (SWRHL-41-r) DAIRY FARM RADIOIODINE STUDIES FOLLOWING THE PIN STRIPE EVENT OF APRIL 25, 1966. Barth, D. S.; Engel, R. E.; Black, S. C.; Shimoda, W. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 1969. 72p. Dep. CFSTI.

A study was mounted at two dairy farms following the inadvertent release of radioactivity from the site of an underground nuclear test (Pin Stripe) conducted at the Nevada Test Site on April 25, 1966. The study produced some results which were similar to those found after the inadvertent release following the Pike event. At the two study farms the effective half-life of ^{131}I was found to be 4.9 and 4.0 days for field forage while the green chop collected from the cow mangers had effective half-lives of 6.9 and 6.7 days, respectively. In the same order, the effective half-lives of ^{131}I in milk from cows eating the green chop were 5.6 and 4.0 days. The milk-to-forage ratios (pCi/liter divided by pCi/kg) were 0.086 and 0.078, respectively. In one of the herds, uncontaminated hay was substituted for contaminated fresh forage after the third day. Over an eighteen day period this countermeasure reduced the potential thyroid dose of humans consuming one liter of the milk per day to only 29% of the dose which would have resulted had no countermeasure been applied. (auth)

43751 (SWRHL-45-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE PHOEBUS IB, EP-I, EP-II, EP-III, EP-IV REACTOR TEST SERIES. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). July 1969. 30p. Dep. CFSTI.

The Phoebus 1B reactor test series consisted of three calibration operations and a full power run. Effluent from the Experimental Plan III(EP-III) operation was detected off-site by one ground monitor and by the presence of 28 pCi/m^3 ^{139}Ba on a prefilter from a portable air sampler operating at an unpopulated location on Highway 95 in Nevada. Effluent from the Experimental Plan IV(EP-IV) operation was detected in air, milk, and vegetation samples and by portable and fixed radiac instruments in Nevada and Utah. The maximum concentration of ^{131}I in milk was 63 pCi/l at the Martin Ranch southwest of Eureka, Nevada. No fresh fission products were found in water samples. In addition to the usual gaseous effluent from a reactor operation, the EP-IV operation resulted in the release of discrete particles of material that were found downwind as far as 80 miles from Test Cell "C." Only one particle was found beyond the Test Range Complex. This particle was found near Diablo, Nevada on Highway 25. This particle had a beta plus gamma reading of 7 mR/hr as measured with an E-500B survey instrument at approximately 1-inch above the ground. This particle was collected at about H + 48 hours. (auth)

43752 (UCD-34-P-104-14) FALLOUT ^{137}Cs ACCUMULATION IN TWO SUBPOPULATIONS OF BLACK-TAILED DEER (ODOCOILEUS HEMIONUS COLUMBIANUS). Book, Steven Arnold (California Univ., Davis. Radiobiology Lab.). June 1969. Contract AT(11-1)-34. 61p. Dep. CFSTI.

Thesis.

Results are reported from an investigation of various parameters influencing the uptake of fallout ^{137}Cs in a wild population of Columbian black-tailed deer (Odocoileus hemionus columbianus) at the Hopland Field Station of the University of California. The variation in ^{137}Cs body burdens of deer living in relatively close proximity yet occupying different elevational habitats was studied in relation to rainfall, type and availability of forage species, foliar contamination by the radionuclide, and dietary preferences. (C.H.)

43753 A RAPID, INEXPENSIVE METHOD FOR THE DECONTAMINATION OF SCINTILLATION COUNTING VIALS.

Harris, John E.; Friedman, Leo (Massachusetts Inst. of Tech., Cambridge). Anal. Biochem., 30: 199-202(Aug. 1969).

A method for the rapid, easy, and inexpensive reclamation of scintillation counting vials is presented. A quick and thorough methanol rinse after emptying is the key step in the procedure. (auth)

43754 CONTAMINATION OF MILK BY ARTIFICIAL RADIOELEMENTS. Morre, J. Aliment. Vie, 55: 149-57(1967). (In French).

The role of nuclear explosions and reactor accidents as sources of radioactive contamination of human food supplies is discussed. A table is presented to show half lives, energy of radiation, and per cent of fission products of various radionuclides. The mechanism of milk pollution is discussed with emphasis on absorption of contaminants of soil by plants eaten by cattle. The metabolism of the principal contaminants of milk is discussed. It is pointed out that ^{131}I is the most dangerous for infants whose diet is chiefly milk; ^{90}Sr is second in importance, and other important contaminants are ^{137}Cs, ^{89}Sr, ^{140}Ba, and ^{140}La. Radioactive contaminants in milk were determined by γ spectrometry, and results for ^{131}I, ^{137}Cs, ^{40}K, and ^{140}La are shown by a graph. Protective measures against radioactive contamination of milk following nuclear accidents are described. By enriching the soil with calcium the animal absorbs less strontium. Animals can be fed with forage collected outside the area of fallout. Since the radioactivity of ^{131}I is negligible after three months, milk should be preserved for three months before feeding to infants. (H.L.W.)

Dosimetry and Monitoring

Refer also to abstracts 43669, 43840, and 43893.

43755 (COO-1500-16) THERMOLUMINESCENT DOSIMETRY FOR PERSONAL MONITORING OF URANIUM MINERS. McCurdy, David E. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). June 1969. Contract AT(11-1)-1500. 168p. Dep. CFSTI.

An accurate dosimetry system using thermoluminescent detectors has been developed for monitoring radiation exposures to individual uranium miners. The system permits the evaluation of cumulative exposures to airborne ^{222}Rn progeny, expressed in units of working level months, as well as the external gamma-ray exposure originating from the ore bodies. Three thermoluminescent materials, LiF, CaF_2: Dy, and $CaSO_4$: Mn, were evaluated as possible radiation detectors of radon progeny collected on a filter paper. Of the three materials, CaF_2: Dy was demonstrated to be superior in terms of sensitivity and fading. The response of CaF_2: Dy-teflon dosimeters was linear for radon progeny exposures ranging from one to 800 working level-liters. The accuracy in determining the working level concentration was approximately ±10%. The response of the dosimetry system was found to be independent of the radon concentration and varying radon progeny equilibrium ratios. The effects of annealing temperature on the thermoluminescence of CaF_2: Dy were analyzed for 17 different temperatures. The thermoluminescence of irradiated CaF_2: Dy was found to be composed of five independent components with each component characterized by a trap depth and a frequency factor. The trap depth, frequency factor, fractional amount each component contributed to the total thermoluminescence, and the decay constant of each component as a function of annealing temperature were experimentally determined for each component. A post-irradiation annealing technique of heating CaF_2: Dy at 115°C for 10 minutes to remove short-lived glow peaks was proposed. Concentrations of airborne ^{222}Rn and radon progeny as well as the external gamma-ray levels were measured within an operating uranium mine located near Golden, Colorado. During the Summer of 1967, radon progeny concentrations averaged approximately three working levels. Gamma-ray levels monitored at several working areas were found to range between 0.2 and 11 mR per hour. (58 references.) (auth)

43756 (CTC-6) THE EXREM II COMPUTER CODE FOR ESTIMATING EXTERNAL DOSES TO POPULATIONS FROM CONSTRUCTION OF A SEA-LEVEL CANAL WITH NUCLEAR EXPLOSIVES. Turner, W. Doyle (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). July 21, 1969. Contract AT(26-1)-171. 91p. Dep. CFSTI.

EXREM II is a computer code to estimate the dose equivalent rate and the total dose equivalent from both beta and gamma radiation resulting from submersion in contaminated water, submersion in contaminated air, and exposure to a contaminated surface. There can be more than one environmental release, and exposure can begin at any time after the first release. EXREM II considers contributions from environmental releases and from nuclide chains. For a particular problem the user may choose to calculate either the dose-rates, or the total doses, or both for any of the three modes of exposure. A separate solution array is printed for each mode of exposure. (auth)

43757 (JUL-566-ST) MEASUREMENT METHOD FOR AIR MONITORING AND ITS USE IN THE ENVIRONMENTAL MONITORING OF THE JUELICH NUCLEAR RESEARCH INSTALLATION. Vogt, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Dec. 1968. 39p. (In German). Dep.

The measurement parameters suitable for monitoring radioactivity in air are considered from the standpoint of the potential paths by which radioisotopes may enter man. The measurement of the inhalation burden from radioactive aerosols, radioiodine, and tritium is the principal subject of the study. The most important enrichment methods are outlined and the methods of measurement and of sampling by filter methods and with filter band devices are discussed. The monitoring of soil doses and estimations of ingestion risks from radioactive material deposited on the soil are considered. A brief survey is included of the air monitoring system of the Juelich Nuclear Research Installation, West Germany. (tr-auth)

43758 (MLM-1615) ENVIRONMENTAL MONITORING REPORT: JANUARY-JUNE 1969. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). Aug. 21, 1969. Contract AT(33-1)-Gen-53. 41p. Dep. CFSTI.

The concentration of radioactive materials detected in the environment surrounding Mound Laboratory, Miamisburg, Ohio, is presented for the first half of 1969. The average concentration of radionuclides from Mound Laboratory in the Great Miami River and in the environmental air was within the stringent standards of safety specified by the Atomic Energy Commission. (auth)

43759 (ORNL-tr-1944) CONSIDERATIONS ON THE RISKS OF IONIZING RADIATIONS IN MANNED SPACE FLIGHTS. REPORT 1. NOTES ON IONIZING RADIATIONS IN EXTRATERRESTRIAL SPACE. Agati, G.; Judica-Cordiglia, A. Translated for Oak Ridge National Lab., Tenn., from Minerva Radiol., 13: 324-34(1968). 22p. Dep. CFSTI.

The risks of ionizing radiations in manned space flights are discussed, with emphasis on the composition and intensity of radiations in the geoatmosphere and in extra-atmospheric space. Within the scope of extra-atmospheric cosmic radiation, the hazards from primary cosmic radiation, solar radiation, radiation from the Van Allen belts, and auroral radiations are considered. After touching on the prospects of future astrophysical research, some data on the exposure of astronauts during the first space flights are presented. (auth)

43760 (TT-67-56003/6, pp 847-60) ANALYSIS OF EXPOSURE OF THE STAFF EMPLOYED IN RADIUM LABORATORIES BY MEANS OF COMPUTING MACHINES. Lubas, Barbara; Lobodziec, Wlodzimierz. Translated from Pol. Przegl. Radiol. Med. Nukl., 31: (1967).

A method of mathematical analysis of exposure is described that was applied to an analysis of the degree of exposure of medical and nursing personnel during skin and gynecologic applications of radium. The method is based on readings of photographic film detectors and four ionization chambers worn on the wrist and chest. (C.H.)

43761 EVALUATION OF DOSES OF RADIOACTIVE ISOTOPES BETA-RADIATION ABSORBED BY THE GASTROINTESTINAL TRACT. Pravdin, V. V.; Faier, S. M. Med. Radiol., 14: No. 8, 10-17(Aug. 1969). (In Russian).

On the basis of the proposed mathematical model of transport of food into the gastrointestinal tract the absorbed doses for different regions were calculated. The results make it possible to evaluate the dose load from beta-emiters. The physico-biological characteristics are presented in detail. (auth)

43762 DOSIMETRY OF NEUTRON BEAMS OF "FAST" REACTOR BY CHEMICAL AND THERMOFLUORESCENT TECHNIQUES. Ryabukhin, Yu. S.; Tkachenko, V. V.; Bologova, G. S.; Vakhlakova, T. V.; Obaturov, G. M.; Vasil'ev, A. G. (Inst. of Medical Radiology, Erevan). Med. Radiol., 14: No. 8, 66-73 (Aug. 1969). (In Russian).

The study of dosimetric characteristics of beams of fast reactors and elucidation of the practical value of selected techniques, combining the ferrosulfate dosimeter with cerium or thermofluorescent one for the separate measurement of neutron and gamma components, required the elaboration of a method of calculating effective radiation-chemical passage in neutron beams of given spectrum. An equation was developed for the combined use of ferrosulfate and thermoluminescent dosimeters; results were ac-

curate for fast neutron beams but less accurate for intermediate neutron beams. In order to increase the accuracy of measurements in lower part of gamma-component it is necessary to carry out additional investigations of the sensitivity of thermofluorescent dosimeter to neutrons, whereby the combination of ferrosulfate and cerium dosimeters proved to be unsuitable for the measurement of D_γ in beams of the BP-5 reactor. (auth)

43763 LIQUID SCINTILLATION RADIOASSAY OF THIN-LAYER CHROMATOGRAMS: PROBLEMS IN THE USE OF EXTERNAL STANDARD QUENCH CORRECTION. Houx, N. W. H. (Lab. for Research on Insecticides, Wageningen, Netherlands). Anal. Biochem., 30: 302-5(Aug. 1969).

Counting efficiency is not affected by the presence of silica gel on the bottom of the vials. However, external standard ratios may erroneously indicate that it is, if the standard source is inserted under the vial so that the silica gel influences the spectrum of the source. Reliable quench calibration curves can be made in this case only for known amounts of silica gel. (auth)

43764 ELECTRON DOSE DISTRIBUTIONS NEAR THE BODY SURFACE. Hattori, Hiroyuki (Aichi Cancer Center Research Inst., Japan); Matsuda, Tadayoshi. Nippon Igaku Hoshasen Gakkai Zasshi, 28: 994-1001(Oct. 1968). (In Japanese).

Depth dose distributions of electron beams emitted from two betatrons were measured by means of a shallow chamber. Each distribution near the surface region showed some difference that may be caused by non similarity of shape and materials of cone and scattering foil. Conclusions obtained were as follows: the large cumulative effect occurs in the case of lower energy and larger irradiation field; the surface dose is less than 90% of maximum dose in the case of lower than 10 MeV of energy and larger than S/L = 1.0 of irradiation field; depth of the peak dose exists in the range of 1.0 ± 1.0 cm in the case of usual scattering foil though it is different in each case; and the energy loss owing to scattering foil was determined by means of extrapolation range method. The comparison of two depth dose curves measured by a shallow chamber and a fluoro-glass dosimeter suggested that the effective center of each dosimeter coincides with its geometrical center in the deep phantom depth. (auth) (NSA of Japan)

43765 FUNDAMENTAL STUDIES ON DOSE DISTRIBUTION OF PENDULUM THERAPY. Takahashi, Kin-ya (Niigata Univ., Japan). Niigata Igakkai Zasshi, 83: 161-70(Apr. 1969).

In measuring the dose distribution of pendulum therapy using ^{60}Co long distance therapy equipment based on the film method, the maximum density area of radiation, i.e., focal rays, and its regularity are influenced by the changes in the pendular angle, the area of irradiation, the depth of pendular axis, and the size of the region to be irradiated. An experiment was performed to investigate the movement of the area of maximum density and whether the movement follows any regular pattern. The following results were obtained. In the pendulum therapy in which the pendular axis was set on the diameter line of the column phantom, the range of the irradiated field was included in the 80% area, i.e., the focal area, under all irradiation conditions. The central point of focal rays moved from the axis to the surface (target side) on the bisector of the pendular angle. The larger the area of irradiation was, that is, the smaller the pendular angle, the larger was the rate of movement of the central point. The rate of the movement of the focus was associated with the depth of the axis and the size of the phantom. That is, the rate of the movement became larger as the phantom became smaller and the axis became deeper. However, even in the irradiation condition with the maximum moving difference (the pendular angle was 20° and the axis was placed 3 cm. deeper than the center of each phantom), the rate was about 2-3 cm at the most. With the 240° pendulum, the movement of the central point of focal rays was influenced only by the area of irradiation. Regularity of the movement of the central point of focal rays was observed in the pendular angle and the area of irradiation. By investigating its regularity, the movement of the central point of focal rays under any irradiation condition can be estimated. The clinical application of the above-mentioned results was tried on the cases of bladder cancer and proved to be sufficiently applicable. (NSA of Japan)

43766 THERMOLUMINESCENCE OF LITHIUM FLUORIDE FOR DOSIMETRY IN CLINICAL PRACTICE. Pychlau, P. Roentgenpraxis, 22: 165-74(July 1969). (In German).

Lithium fluoride dosimeters are evaluated from 16 literature references and experimental data. Preirradiation thermal annealing, energy dependence, and dose rate effects are discussed. (H.B.G.)

43767 SPACE IONIZING RADIATION AS A PROBLEM IN AVIATION AND SPACE MEDICINE. Clemedson, C. J. pp 163-78 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967.

Problems involved in estimating doses from space ambient radiation received by astronauts during space flights and by the crew and passengers of supersonic transport aircraft within the atmosphere are discussed. The main types of radiations of interest in space are reviewed and estimates are presented of the exposure rate from galactic cosmic radiation, geomagnetically trapped radiation (Van Allen belts), solar flare proton events, and secondary radiations. The biological effects of various doses of radiation on man and the effects of shielding on the radiation dose received by astronauts while in the space cabin are considered. The value of radiation monitoring for both space and supersonic flight is discussed. Radiation safety criteria for future manned space missions based on a biologically acceptable dose for a once or twice in a lifetime exposure are discussed. For supersonic flight, it is suggested that ICRP recommendations for maximum permissible radiation dose for radiation workers and for the general public be used as the basis for radiation safety criteria for aviation personnel and passengers, respectively. (C.H.)

43768 DOSIMETRIC FINDINGS ON THE CHARACTERISTICS OF IRRADIATION OF THE NERVOUS SYSTEM AFTER INCORPORATION OF $Na^{131}I$. Ulitovskii, D. A. Zh. Nevropatol. Psikhiat., 67: 1162-7(1968). (In Russian).

The toxicological importance of the clinical use of iodine-131-labeled sodium iodide is pointed out. In the present investigation calculations were based on direct examination of tissues of 45 patients. It was estimated that the nervous system absorbs only 2% of the total dose introduced into the organism. However, the doses to localized structures are significant. There is a considerable effect on the more exposed zones and the effective doses differ markedly from the actual Parmi doses to the central nervous system. There is an increased dose to the cervical part of the spinal marrow; the dose to the nerves of the neck is further increased; and the dose to the receptor apparatus and efferent nerves of the thyroid gland is still more increased. The role of the different factors in irradiation of various parts of the nervous system varies according to anatomical conditions. (tr-auth)

43769 GENERAL FORMULA FOR EQUATING PROTRACTED AND ACUTE REGIMES OF RADIATION. Liversage, W. E. (Charing Cross Hospital, London). Brit. J. Radiol., 42: 432-40 (June 1969).

Suppose that a continuous low dose-rate radium treatment lasting t hours is replaced by a high dose-rate after-loading treatment employing N fractions. Theory, based on the recovery of intracellular sub-lethal damage, suggests that the total fractionated dose necessary to produce an equivalent effect on each irradiated tissue will be the same as the protracted dose, provided N and t are related by a formula which, for values of $t > 12$ hours, approximates to $N = t/4$. If, in order to give N fractions without spacing them too close together, the overall treatment time is increased to $(N - 1)$ days, the total fractionated dose should, however, be increased by C rads for each day by which the overall time is increased. It is suggested that for skin C is approximately equal to 25 rads per day. The formula is shown to be valid for skin reactions in patients and for $LD_{50(30)}$ in mice. Theory suggests that the formula is likely to be approximately true for most mammalian tissues irradiated at normal body temperature, irrespective of their recovery regression coefficients. Thus, changing to a high dose-rate regime should produce no deterioration in the therapeutic ratio provided the treatment is fractionated in accordance with the proposed formula. If the number of fractions is reduced from N to some lower number, the corresponding reduction in required dose may be found using the formula of Ellis (1967) or the nomogram of Shuttleworth and Fowler (1966). Such a change may, however, be accompanied by a change in therapeutic ratio. (auth)

43770 GAMMA DOSE RATE AT AN INTERNAL POINT ON THE AXIS OF A SOLID RADIOACTIVE SPHEROID SOURCE. Gupta, P. C.; Gupta, M. M. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Int. J. Appl. Radiat. Isotop., 20: 275-81(Apr. 1969).

A formula was derived for the γ-dose rate at an internal point on the axis of a solid spheroidal source having uniform distribution of radioactivity. The spheroidal source was compared with a cylindrical source of comparable geometry at the point of interest. The effect of change of geometrical configuration on the dose rate was studied in detail using an IBM-1620 computer. (auth)

43771 THREE ASPECTS OF THE DOSE CONCEPT FOR IRRADIATED PERSONS. Le Go, R. Radioprotection, 3: No. 2, 97-113(1968). (In French).

A biological definition of the concept dose was established to allow comparison of hematological processes in different cases of accidental exposure to radiation. It is possible to calculate successively: the dose received by the phantom (perspex model); the average calculated bone-marrow dose, and the corresponding relative biological effective dose calculated from the survival rate of stem cells of the bone marrow. The latter value may indicate the hematological evolution in cases where the bone marrow is the critical organ. It introduces the concept of critical cell (myeloid stem cell) as the necessary basis for comparison of doses. This relative biological effective dose related to the bone marrow allows the chance of survival to be estimated, and prognostic and therapeutic conclusions to be drawn. (UKAEA Info. Bulletin)

43772 INTRACAVITARY SCINTILLATION MEASUREMENTS OF ABSORBED DOSES OF LONG-WAVE X RADIATION. Narkevich, B. Ya.; Konstantinov, I. E.; Korf, N. N. (Moscow Engineering Physics Inst.). Med. Radiol., 14: No. 6, 54-7(June 1969). (In Russian).

A technique is proposed for measuring the absorbed dose in biological tissue using a scintillation dosimeter. A device with a portable scintillation pick-up was designed for intracavitary and phantom measurements of absorbed doses of x and γ radiation. The problems concerned with the technique of measurements are discussed and results of measurement of absorbed doses for mice irradiated with x rays on a PYM-7 apparatus are presented. (auth)

43773 ABSORBED RADIATION DOSE IN SOME SCINTIGRAPHIC STUDIES. Husak, V. Cesk. Radiol., 22: 297-307 Sept. 1968). (In Czech).

The technique for calculating the absorbed dose from radioisotopes employed in some scintigraphic investigations is explained. All methods currently in use for the purpose of calculating the absorbed dose of gamma radiation are set out. The paper presents formulas, tables and graphs providing rapid information on the physical characteristics of isotopes and on the values of absorbed doses in the kidneys, liver, spleen and thyroid gland. At the same time total body dosages are also calculated. Stress is laid mainly on correct calculation of absorbed dosage in the case of isotopes which, apart from beta and gamma radiation, also emit roentgen rays, conversion and Auger's electrons. (auth)

43774 RADIATION DOSE TO THE SKIN IN DIAGNOSTIC RADIOGRAPHY. Rogers, R. T. (Westminster Hospital, London). Brit. J. Radiol., 42: 511-18(July 1969).

Doses to the skin received by patients undergoing radiographic examination have been calculated for all the positions and views detailed by K. C. Clark in Positioning in Radiography and by Ilford Ltd. in the booklet X-ray Exposure Record. Doses are given with and without the effect of back-scatter. (auth)

43775 IN VIVO MEASUREMENT OF LUNG BURDENS OF RADIONUCLIDES EMITTING SOFT, PENETRATING RADIATIONS. Laurer, Gerard R. New York, New York Univ., 1968. 154p. Thesis.

Research was conducted to develop a method for in vivo measurement of low energy photon emitters using thin, scintillation crystals. Measurements of S^2/B for various CsI(Tl) crystal thicknesses and photon energies indicated that optimum thickness was a function of energy and that a 1 mm thick crystal was the best compromise for the efficient detection of photons from 17 keV to 100 keV. A dual crystal (CsI–NaI) anticoincidence system, employing pulse shape discrimination, was developed. Use of this technique reduced low energy γ-ray background (12 keV to 200 keV) by 70% over conventional thin crystal systems. The dual crystal principle was employed in the design and construction of an 8 in. diameter detector consisting of a 1 mm thick CsI(Tl) crystal optically coupled to a 2 in. thick NaI(Tl) crystal. Calibration of this system, inside a steel room, for the in vivo measurement of lung burdens of ^{239}Pu, $^{90}Sr-^{90}Y$, and natural uranium, has yielded MSA's of 2.5 nCi, 4.9 nCi, and 3 mg respectively. Calibrations were also performed outside the steel room to test the feasibility of the system, which is relatively light weight and compact, as a portable, in vivo monitor for emergency field situations. In an application of its field use, the system was used on the Colorado plateau to measure nCi levels of ^{210}Pb (47 keV) in uranium miners. Calculations of cumulative exposure to radon daughters from in vivo measurements of ^{210}Pb in four exminers, at our laboratories prior to the field trip, compare favorably with available data concerning the miners' cumulative exposures obtained by air samples taken in the mines periodically over their working years. (Diss. Abstr.)

43776 CALCULATION OF INTEGRATED DOSES IN HIGH ENERGY ELECTROMAGNETIC RADIATION BY AN APPROXIMATIVE METHOD. Dubinin, I. (Katedra Radiologie Lekarske Fakulty, Brno). Cesk Radiol., 22: 314-17(Sep. 1968). (In Czech).

A simple method for calculating integrated doses in high-energy electromagnetic radiation sufficiently accurate for practical requirements is described. (tr-auth)

43777 ISODOSES OF THE NEW WEDGE FILTER OF THE SIEMENS "GAMMATRON". Debois, Jean M. Strahlentherapie, 138: 59-61(July 1969).

The isodoses for the new wedge filters designed for the Gammatron–Siemens telecobalt apparatus were measured. They give an appropriate selection of modified beams that can be used in various radiotherapeutical indications. (auth)

43778 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 9: 545-60(Oct. 1968).

Data are presented by the Pasteurized Milk Network of the United States on the ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba content of pasteurized milk during June 1967 through June 1968. The Canadian Milk Network presents data on the Ca, K, ^{90}Sr, and ^{137}Cs content of whole milk during June 1968, and the Pan American Milk Sampling Program presents data on the K, ^{90}Sr, and ^{137}Cs content of milk during June 1968. The Colorado, Florida, Tennessee, and Texas Milk Networks present data on the K, ^{89}Sr, ^{90}Sr, ^{131}I, ^{137}Cs, and ^{140}Ba content of milk samples during April through June 1968. Food and diet surveillance activities included sampling of the Ca, K, ^{90}Sr, ^{137}Cs, and ^{226}Ra content of institutional total diets of children and adults during January to March 1968. All data are presented in tabular form. (E.R.B.)

43779 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 9: 570-7(Oct. 1968).

Data are presented from the Radiation Alert Network sampling program on the gross β radioactivity in surface air and precipitation in the United States during June 1968 and a monthly profile is given for 1962 through June 1968. Results are also presented for the June 1968 sampling of the gross β radioactivity in surface air and precipitation by the Canadian Air and Precipitation Monitoring Program, the gross β radioactivity in airborne particulates sampled by the Mexican Air Monitoring Program during June 1968, and the gross β radioactivity in surface air samples by the Pan American Air Sampling Program for June 1968. (E.R.B.)

43780 OTHER DATA. Radiol. Health Data Rep., 9: 578-617 (Oct. 1968).

Data from a comprehensive analysis of the environmental radioactivity in Mexico are presented. Included in these data are: gross β radioactivity of airborne particulates; ^{40}K, ^{90}Sr, and ^{137}Cs content of surface air; gross β radioactivity in rainwater; gross β radioactivity in lake, river, and drinking water; ^{90}Sr content of milk; gross β radioactivity in food; and gross β radioactivity in seawater. All data are presented in tabular form and represent sampling activities during January through June 1967. The ^{90}Sr content of human bone samples in the United States during July to September 1967 as well as the ^{90}Sr content of human vertebrae during 1967 are given. Data on the environmental radioactivity levels at Atomic Energy Commission installations include off- and onsite monitoring of α, β, and γ radioactivity at National Reactor Testing Station in Idaho and Oak Ridge Area in Tennessee during July to December, 1967. The Atomic Energy Commission announces that four low- to intermediate yield underground nuclear tests were conducted at the Nevada Test Site during September 1968, and an underground nuclear test was recorded from the Soviet underground test facility. (E.R.B.)

43781 DATA ON WATER. Radiol. Health Data Rep., 9: 561-9(Oct. 1968).

Data are presented on the gross α and β radioactivity in surface waters of the United States during April 1968, and the tritium content of surface waters at selected sites in the United States during 1967. Data are also presented on the α and β radioactivity in raw and treated water supplies in Minnesota during July to December 1967 and the gross β radioactivity and ^{90}Sr content of selected raw surface water samples in New York during June to December 1967. All data are presented in tabular form. (E.R.B.)

43782 A PILOT SURVEY OF X-RADIATION EMISSIONS FROM COLOR TELEVISION RECEIVERS IN PINELLAS COUNTY, FLORIDA. Radiol. Health Data Rep., 9: 525-30(Oct. 1968).

A pilot survey was conducted in Pinellas County, Florida, in November 1967 to evaluate methodology and techniques for use in determining the effectiveness of General Electric Company's modification program of color television receivers and in assessing the total radiation emission situation for television sets of all manufacturers. The instrument used was designed by the National Center for Radiological Health to facilitate rapid home surveys. To further document the source, size, shape, and intensity of emissions, radiographic films were exposed on selected receivers.

The primary object of this survey was to evaluate the effectiveness of the downward beam modification program. Within the limits of this survey, the General Electric Company's downward beam modification program was found effective. The initial survey determined that 43 of the 148 sets had x-ray emissions in excess of 0.5 mR/hr; after modification, all sets emitted less than 0.5 mR/hr. A second object of the survey was to evolve and test new instruments and new methods of measurement for a future survey of television sets produced by all manufacturers. (auth)

43783 A SUMMARY OF THE WASHINGTON, D. C. METROPOLITAN AREA SURVEY OF COLOR TELEVISION RECEIVERS. Radiol. Health Data Rep., 9: 531-8(Oct. 1968).

A survey was conducted by the National Center for Radiological Health (NCRH) during December 1967 and January 1968 with the cooperation of the Electronic Industries Association and individual manufacturers to obtain x-ray emission data from color television receivers owned by Public Health Service employees in the Washington, D. C. area. Radiation measurements using a survey instrument developed by the NCRH, were made on 1,124 color television sets of various makes and models. Of these sets, 66 emitted x rays at exposure rates at or in excess of the recommended level of 0.5 mR/hr. The x-ray emissions were reduced to acceptable levels through service adjustments, such as replacement of shunt regulator or rectifier tubes and reduction of the operating high voltage. The survey results are considered to be valid only for the sample of sets examined in the Washington, D. C. area. (auth)

43784 SUMMARY OF GONADAL AND GENETICALLY SIGNIFICANT DOSE FROM X RAYS IN THE UNITED STATES, 1964. Segal, Phyllis; Brown, Morton L. (National Center for Radiological Health, Rockville, Md.). Radiol. Health Data Rep., 9: 539-43(Oct. 1968).

A survey was conducted in 1964 by the U. S. Public Health Service to obtain information on the x-ray experience of the U. S. population. The survey was conducted in five parts: household interviews to obtain x-ray visit data; mail followup to x-ray facilities to obtain technical data; processing of x-ray visit data to obtain estimates of x-ray visits and examination; development of domestric models for estimating gonadal dose; estimation of gonadal doses and the genetically significant dose for U. S. population based on dosimetric models and exposure data. The survey indicated that a reduction in gonadal dose had occurred over a period of time and that this reduction was the result of improved collimation of diagnostic x-ray beams. (E.R.B.)

Radiation Protection

Refer also to abstracts 43749 and 43791.

43785 SOME PRACTICAL FACTORS INFLUENCING THE DESIGN OF THE X-RAY DEPARTMENT. Goddard, J. F. (Newcastle Regional Hospital, Newcastle upon Tyne, Eng.). Radiography, 34: 273-7(Dec. 1968).

Construction practices for radiography clinics that will ensure radioprotection of staff and adjacent office personnel are outlined. While flexibility is desirable to allow future scope for building extension, the radiation level together with the necessity to fix heavy surface-mounted control gear complicates the use of a lightweight wall structure. For standard rooms, adequate radiation protection can be achieved by using 9 in. thickness of engineering bricks. Concrete blocks are inadequate because of their relative low absorption of x rays. This also applies to hollow or perforated brick. Where walls are subjected to the primary beam, additional protection can be readily achieved by a finish of Ba plaster, the specified thickness of which will depend upon the particular use of the adjoining accommodation. The corrosive effects of Ba plaster upon concealed engineering services such as wiring conduits and water pipes can be retarded by local application of cement slurry. However, such precautions can often be made unnecessary if the Ba plaster is applied to the other side of the wall. Where recessed fittings such as cupboards and flush film-viewing illuminators are sited, the radiation protection levels must be maintained by additional backing with sheet lead of appropriate thickness. Architraves need lead backing treatment to maintain radiation protection levels. When the upper floor structure above the standard x-ray room ceiling has a 5 in. concrete thickness, no additional radiation protection treatment is generally required. Should this not be the case, knowledge of the characteristic occupancy of the accommodation above will influence the final recommendations made by the radiological protection adviser. In some cases the central part of the upper floor area can be covered with an underlay of sheet lead ($2\frac{1}{2}$ lb/ft^2, equals 1 mm). This is simpler than lining the ceiling with Pb or Ba plaster. Where x-ray rooms are sited above other accommodations, the floors must be of sufficient density to absorb direct radiation (6 in. of concrete is equivalent to about 2 mm of Pb. (BBB)

43786 HEAD SHIELDING PROTECTION FOR BEAGLES EXPOSED TO SUPRALETHAL DOSES OF PULSED MIXED GAMMA-NEUTRON RADIATIONS. Thorp, James W. (Defense Atomic Support Agency, Bethesda, Md.). Aerosp. Med., 40: 759-61(July 1969).

Five groups of beagles (8 per group) received supralethal doses of pulsed, mixed gamma-neutron radiations from a TRIGA reactor. Exposures included unshielded, head shielded, and trunk shielded dogs. The midline tissue dose behind the shield was approximately six percent of the midline tissue dose at the same point without the shield in place. Head shielding prolonged survival and effectiveness, but trunk shielding was not beneficial. Unshielded and trunk shielded dogs which received 14,000 rads to the head all exhibited symptoms of central nervous system (CNS) damage within 20 minutes postexposure; survival times were 18.5 ± 1.9 and 26.0 ± 5.6 hours, respectively. Symptoms of CNS damage occurred immediately in trunk-shielded dogs which received 22,000 rads to the head; survival time was 15.8 ± 2.4 hours. There were no overt symptoms of CNS damage in head-shielded dogs that received 19,000 or 25,000 rads to the chest, and their survival times were 45.4 ± 5.3 and 26.1 ± 1.3 hours, respectively. (auth)

43787 RADIOBIOLOGICAL ASPECTS OF RADIATION SAFETY OF COSMIC FLIGHT. Grigor'ev, Yu. G.; Kovalev, E. E. pp 207-11 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967. (In Russian).

Ionizing radiation is one of the dangerous factors influencing unfavorably the crew and life support system of space ships. There is some specifity in setting permissible radiation levels for the crew of space ships. These levels are established according to concrete flight conditions, information on the radiobiological action of cosmic rays, and space distribution of absorbed dose. It is necessary to extend the number of critical organs, taking into account space flight conditions and the influence of ionizing radiation on analyzers; it is necessary also to estimate effective doses for the case of repeated radiation exposures resulting from solar flares. Radiation protection of the crew depends on wall thickness of the ship, equipment arrangement, flight path, flight duration, state of sun activity, etc. The most promising approach as regards radiation safety is combined protection which includes general, local, and individual protection of astronauts. Radiation factor during prolonged space flight sets new tasks for further radiobiological and physical experimentation to study the problem of radiation safety of space ships. (auth)

43788 IONISING RADIATIONS: PRECAUTIONS FOR INDUSTRIAL USERS. Safety, Health and Welfare, New Series, No. 13. London, Her Majesty's Stationary Office, 1969. 72p. 5s. Od.

Safe practices for the industrial use of sealed and unsealed radiation sources and generators are recommended, and the legal requirements are explained. Industrial applications considered include gamma and x-ray radiography; x-ray fluoroscopy; x-ray crystallography and spectroscopy; static elimination; thickness level and density gauging; package monitoring; luminizing; and tracer work. (UK)

Safety Procedures

Refer also to abstracts 43424, 43439, and 43749.

43789 (TID-25128) OPERATIONAL ACCIDENTS AND RADIATION EXPOSURE EXPERIENCE WITHIN THE UNITED STATES ATOMIC ENERGY COMMISSION, 1943-1967. (Division of Operational Safety (AEC), Washington, D. C.). Dec. 1968. 53p. Dep. GPO $0.60.

The causes of occupational injuries and fatalities of personnel in AEC programs from 1943 to 1968 are summarized. During this 25-year period there were 35 workers involved in lost-time radiation nonfatal accidents, including 11 workers removed from work for observation but who developed no signs of radiation injuries. There were six deaths attributable to nuclear causes; three of these occurred as the result of separate accidents at Los Alamos in 1945, 1946, and 1958 and were the direct result of exposure to a massive dose of nuclear radiation. The three additional fatalities were caused by the effects of blast and flying missiles associated with the SL-1 reactor excursion in 1961. However, the radiation levels were extremely high and probably would have been fatal. The non-fatal radiation accidents were caused by human error, faulty manipulation of controls, deviation

from standard operating procedures, or faulty mechanical equipment. Fatalities from all causes totaled 276 during the 25-year period, of which 166 occurred in construction; 98 in AEC operations, including production, research, and services, and 12 in Government functions. During this period the lost-time injuries, attributed to all accidental causes resulted in a frequency rate of 3.11% per million man-hours. Data on all accidents involving loss of work time by personnel, criticality accidents in AEC facilities, and accidents resulting in property loss of over $50,000 are summarized. (C.H.)

43790 4th NATIONAL MEETING ON HEALTH PHYSICS PROBLEMS, YAVNE, ISRAEL, AUGUST 31, 1966. Abstracts of Papers. Yavne, Israel, Israel Atomic Energy Commission, 1966. (In Hebrew and English). (CONF-660829-(Absts.)).

Abstracts of the eight papers presented at the fourth national meeting of The Israel Society for Radiation Protection and The Isreal Atomic Energy Commission's Radiation Safety Department are presented. Six of the abstracts are in Hebrew. The other two, in English, discuss the detection of radiation exposure using fluorescent microscopy blood cells and the transfer of ^{144}Ce by way of the placenta and during lactation to offsprings of mice. (E.R.B.)

43791 LABOR PROTECTION IN GAMMA-RADIOGRAPHY. pp 210-57 of Industrial Radiology. Rumyantsev, S. New York, Gordon and Breach, Science Publishers, [1969].

The effects of radioactivity on the human organism are discussed briefly with attention given to the rationale behind the maximum permissible doses and dose rates over a period of time for industrial personnel. The efficiency of shielding devices, whether stationary or portable is based on the dose reduction to the personnel from a radiation source. Calculations are given for head-on γ radiation shielding. Three methods for calculation are discussed. Shielding calculations are also given based on the physical dose-reduction factor, physical dose-rate reduction factor, reduction of radioactive source activity, changes in exposure time and distance, and half-value layers. Calculation of shielding for radioactive sources of a complex spectrum is discussed and the use of universal charts in these calculations is illustrated. Charts are also employed to facilitate the calculation of the thickness of protective barriers by the measured dose rate. Scattered γ radiation shielding values are also discussed. When it is not economically feasible to provide adequate shielding for personnel, protection can still be assured by placing the source at a safe distance from the personnel and reducing the irradiation time. The cost of shielding materials is determined by the type of shielding used, and often materials cheaper than lead can be used such as concrete or steel. Other protective materials include lead glass, lead rubber, tungsten, black metals, barytes, and barytes concrete. Gamma-radiation health monitoring is discussed in terms of the instruments employed, and a section is devoted to gamma-inspection laboratories where the major problem involved is an open gamma source. Here again, source-to-personnel distance becomes extremely important. (E.R.B.)

43792 OCCUPATIONAL HAZARDS IN DENTISTRY. Federico, Andrew N. J. N. J. State Dent Soc., 40: 73-9(Oct. 1968).

The occupational hazards in dentistry and treatments and methods of protecting against them are discussed. The injuries mentioned are those to the hands, feet, eyes, and internal organs, including the nervous system. Radiation hazards from the x-ray machine and the permissible radiation dose are given. (F.M.M.)

43793 MEDICAL JUDGEMENT OF THE EMPLOYABILITY OF WORKERS AT PLACES WITH RADIATION HAZARD. Geszti, Olga; Lovanyi, Istvan; Predmerszky, Tibor (Sugarbiologiai es Sugaregeszsegugyi Kutato Intezet, Budapest). Atomtech. Tajek., 11: 412-20(Aug. 1968). (In Hungarian).

Based on data from literature and personal experiences, the indication and contraindication of employment, the importance of periodical medical examination, as well as the problems in determining radiation injury and in treatment are discussed and summarized. (TSS) (auth)

43794 BLOOD PICTURE IN EMPLOYEES OF URANIUM MINES IN THE DISTRICT OF PRIBRAM. Kriklava, J.; Vich, Z. (ZUNZ, Pribram, Czech.). Cas. Lek. Cesk., 107: 1367-72(1968). (In Czech).

Haemograms in 4021 men including 3642 miners of uranium mines were evaluated. They were divided into five groups according to the period of work exposure. It was found that the average values of some indicators in exposed subjects differed significantly from the average assessed in the control group. The results were subjected to a detailed analysis with regard to the accepted borderline of physiological values in the normal male population and it was found that none of the ascertained levels was beyond this range. The examination of the hemogram did not show evident damage of hematopoiesis, though the working environment had a bearing on the hemogram. (tr-auth)

Civil Defense

Refer also to abstract 43512.

43795 (AD-837275) BIBLIOGRAPHY AND ABSTRACTS: ARMED SERVICES AND OTHER GOVERNMENT AGENCIES PUBLICATIONS ON NUCLEAR RADIATION, COMMAND OPERATIONAL EXPOSURE GUIDANCE, AND CONTAMINATION CONTROL LEVELS. Adams, Adam E.; Stefani, Louis J. (Defense Atomic Support Agency, Washington, D. C.). May 20, 1968. 83p. (DASA-2107). CFSTI.

The bibliography is primarily intended to identify and compile military operational reference material published by the military services and selected government agencies, which relate to nuclear radiation, command exposure guidance and contamination control levels. No attempt has been made to list all service-sponsored or government agencies' publications which do not relate directly to military peacetime or wartime operations. The synopsis given for each reference is not intended to cover all the data of interest in the document. It is designed to provide some of the highlights of the pertinent information as an indicator of the type of data that can be found in the document. (auth) (USGRDR)

Legal Aspects

43796 (DMRE-69-2) SYMPOSIUM ON PAST, PRESENT, AND FUTURE STATE X-RAY PROGRAMS, MAY 21-22, 1968, ATLANTA, GEORGIA. Britain, Robert G.; Payne, H. Richard (eds.) (Bureau of Radiological Health, Rockville, Md.). May 1969. 107p. (CONF-680548). Dep.

The three major problem areas that contribute to the unnecessary exposure of the population to x radiation are discussed. These include the continued use of x-ray equipment that does not meet accepted standards; the use of equipment by operators who are not competent in the use of the more advanced techniques; and the use of diagnostic radiography in an injudicious, repetitive, and ineffective manner. There has been a vast difference from State to State in regard to the type and depth of initial x-ray survey performed. The types of surveys have ranged from strictly equipment evaluations to educational surveys lasting several hours. To complicate matters, States have utilized different survey report forms which has made it difficult to compare the effectiveness of State programs. The type of initial survey a State performs will depend to a great extent on the desired survey frequency, the manpower available to the program, and the presence or absence of regulations. The deficiencies found during an x-ray survey should be explained in detail to the person in charge of the facility. This individual may be a hospital administrator, a radiologist, or a general practitioner, and it is he who bears responsibility for the correction of defects noted in the survey report. It has been suggested that the x-ray surveyor not operate x-ray equipment during a survey when there is a technician or physician available. Otherwise, he should obtain clearance from the person in charge of the facility. The Public Health Service survey forms should be redesigned to include both PHS and State needs. The survey forms might, then, become more accepted and used more widely by the States. This would also be a step toward more uniform State x-ray surveys. There are several items in State radiological health regulations that are being intentionally overlooked during the survey or exempted. They include, for example, an evaluation of timers on fluoroscopes and interlocks on certain therapy units. Consideration should be given to removing such items from the regulations and making them recommendations. (auth)

43797 SOME JURIDICAL ASPECTS OF PROTECTION OF PATIENTS AGAINST THE RISKS OF IONIZING RADIATIONS: NOTES ON ITALIAN LEGISLATION IN FORCE AND POSSIBLE FUTURE PROSPECTS. Polvani, G. M. Minerva Fisiconucl., 11: 93-100(1967). (In Italian).

The most recent Italian legislation on radiation protection is used to illustrate how the attention of the legislator is directed toward the protection of the worker and to that of the population as a whole, in which the patient constitutes a particular case. The possible future legislation needed to close this gap is indicated. (J.S.R.)

43798 IONISING RADIATIONS: PRECAUTIONS FOR INDUSTRIAL USERS. SECOND EDITION. London, Her Majesty's Stationary Office, 1969. 72p. 5s.

The following topics are reviewed: Radiation hazards; properties of radioactive materials; basic principles of protection; legislation and codes of practice; ICRP and maximum permissible levels; general requirements applicable to regulations made under Factories Act; special requirements of the Ionizing Radiations (Sealed Sources) Regulations 1969; special requirements of the Ionizing Radiations (Unsealed Radioactive Substances) Regulations 1968; luminizing and tracer work. (UK)

Medicine

Protective Substances

Refer also to abstracts 43690, 43728, 43865, 43885, 43909, and 43912.

43799 BEHAVIOR OF THE RAT MANDIBLE FOLLOWING MAXIMUM IRRADIATION WITH SIMULTANEOUS ADMINISTRATION OF VASO-ACTIVE AND VASOCONSTRICTING SUBSTANCES. Heiss, J.; Grasser, H. (Univ., Munich). Deut. Zahnaertztl. Z., 23: 1410-17(Dec. 1968). (In German).

Radiotherapy or high voltage x-ray therapy of the facial-maxillary region, apart from dermal erythemas, particularly affects the bony structures. The radiation damage predominantly affects the osteoblasts and vessels, particularly the capillaries. The substances Venoruton, Tanderil, Ronicol, and Hostacaine that are clinically already known to have a therapeutic effect against radiation stress, were tested in an experimental study at dosage levels of 5,700 R. In these tests it was possible to observe that administration of Venoruton and Tanderil could restrict osteoradionecrosis and that administration of Ronicol and Hostacaine could almost certainly prevent it. (auth)

43800 MODIFICATION OF IRRADIATION EFFECTS ON RAT PAROTID BY CHRONIC PRETREATMENT WITH ISOPROTERENOL. Schneyer, Charlotte A.; Finn, Raymond J. Jr.; Phillips, Rodney M. (Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med., 131: 723-7(July 1969).

Twice daily administration of the sympathetic amine, isoproterenol (ISO), for 2 or 3 days prior to x irradiation (3000 R) of rat parotid glands afforded protection from the effects of irradiation and the usually observed changes in size and structure of the gland did not occur. When the amine was administered for shorter periods (1.5 hr) or much longer periods (10 days) no protection against the effects of irradiation was observed, and under these conditions, the usual radioinduced effects (i.e., reduction in size of gland and of acinar cells, and pyknosis and fragmentation of nuclei) were seen. The protective effects of isoproterenol were not considered related either to increased secretory activity of the gland or to the presence of this catecholamine. The ISO also causes a gland enlargement characterized by an early phase (following initiation of the ISO regimen) of increased mitosis (2 to 4 days) with diploid and polyploid cells produced, and a later phase (without discernible mitosis) of hypertrophy (10 days ISO). The protection afforded by ISO therefore appears related to the gland enlargement induced by the ISO, and in fact to the early phase characterized by hyperplasia. (auth)

43801 AN EXPERIMENTAL CONTRIBUTION TO THE POSSIBILITY OF THE UTILIZATION OF THE RADIOPROTECTIVE COMPOUND AET. Dienstbier, Z.; Pospisil, J.; Kotatko, J. pp 179-84 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967.

The possibility of using AET to protect astronauts against the effects of radiations in space are considered. Data on the radioprotective and toxic effects of AET in cats, mice, and dogs are reviewed. It was concluded that the toxic effects of radioprotective doses of AET would preclude its use in astronauts. (C.H.)

43802 RADIOPROTECTIVE EFFECT OF THE AMINO ACID COMPLEX ORNITHINE-ASPARTATE ADMINISTERED EITHER BEFORE OR AFTER IRRADIATION WITH 1000 r AND 1200 r. Szirmai, E.; Medgyesi, G.; Knapp, J.; Keinert, J. (Univ., Stuttgart). Therapiewoche, 19: 1298-1301(July 16, 1969). (In German).

Several groups of rats were exposed to either 1000 R or 1200 R of x radiation and liver glycogen, blood glucose, and transaminase were determined. In comparison to controls, the irradiated animals showed an increase in liver glycogen and transaminase. Administration of ornithine-aspartate largely prevented this increase. Thirty-day survival time of animals receiving ornithine-aspartate either before or after irradiation was approximately 50%; while it was only 5% in untreated rats. (H.B.G.)

43803 RADIATION LIFE SHORTENING DATA. Dunjic, Anta (Univ., Louvain, Belgium). Strahlentherapie, 138: 123-7(July 1969).

The influence of genetic factors, chemical agents, and thymus, on radiation life shortening are reported. Some data on radioisotope investigations on late functional radiation changes in the rat are discussed. (auth)

Radiation Sickness and Injuries

Refer also to abstract 43892.

43804 PATTERN OF RECOVERY OF ERYTHROPOIESIS IN HEAVILY IRRADIATED MICE RECEIVING TRANSPLANTS OF FETAL LIVER. Kubanek, Bernhard; Rencricca, Nicholas; Porcellini, Adolfo; Howard, Donald; Stohlman, Frederick Jr. (Tufts Univ., Boston). Proc. Soc. Exp. Biol. Med., 131: 831-4(July 1969).

The recovery of erythropoiesis in heavily x irradiated mice receiving fetal liver was compared with that of mice receiving adult bone marrow. The number of cells was adjusted so that each group received a comparable number of cfu. Red cell production as judged by both iron incorporation and peripheral reticulocyte values began earlier in the fetal liver transplant than after adult bone marrow. Further, the extent of erythroid colonization of the bone marrow appeared greater in recipients of fetal tissue than adult. These differences in the recovery pattern suggest that stem cell regulation of fetal erythropoiesis differs from that of the adult. (auth)

43805 STUDY OF GENETIC INCORPORATION OF EXTRACELLULAR DEOXYRIBONUCLEIC ACID BY IRRADIATED HOST CELLS. Nambiar, K. Govindan. College Station, Tex., Texas A and M Univ., 1968. 95p.

Thesis.

A series of 18 experiments involving a total number of 1506 chicks were conducted to evaluate the comparative efficiency of deoxyribonucleic acid (DNA) from different sources (homologous, autologous, and heterologous) in post-irradiation therapy. DNA was injected following lethal irradiation of the recipient, to determine if homologous DNA molecules could be utilized by the irradiated host cells as sequentially arranged nucleotides bearing genetic expression. Also an in vitro study was made to determine the ability for DNA to pass into and out of chicken erythrocytes. The data show that the chicks that were injected with autologous DNA had a survival rate significantly higher than that of irradiated untreated controls. Bone marrow transplant also gave a significantly higher survival rate than that of the irradiated controls. The survival rate of chicks injected with autologous DNA was not dependent upon any particular route of administration (intravenous, intraperitoneal or subcutaneous) and absorption of the DNA took place without any evidence of harmful reactions. The therapeutic effect of autologous DNA increased as the amount injected increased with the limits studied. The highest concentration studied was 1800 micrograms. This was the maximum DNA yield obtainable from chicks 14 days of age without causing death of the bird prior to irradiation. The administration of pooled sire and dam DNA was therapeutically beneficial for lethally irradiated chickens and the survival rate was equal to the survival rate obtained for autologous DNA when administered in identical quantity (i.e., 1800 micrograms plus 1800 micrograms of sire and dam DNA). There was evidence that the therapeutic efficiency in terms of 30 day survival was proportional to the quantity of sire plus dam DNA administered. The survival rates were respectively, 25.00, 41.51, and 72.41% for 900 + 900, 1800 + 1800 and 7200 + 7200 micrograms of pooled DNA of sire and dam. The survival rate for dam or sire DNA alone group was 31.5%. These results indicate that the irradiated host cells are able to utilize DNA efficiently only if sequential arrangement of the bases is the same as that of host cells and that they are used for repair of whole blocks of nucleotides destroyed by irradiation. Under the conditions of these experiments, there was no evidence of therapeutic benefits derived from the use of homologous DNA immediately following lethal x irradiation of 1800 R given with 40 min intervals between each 300 R. Similarly, no therapeutic beneficial effect could be observed from the injection of heterologous DNA (commercial). The experiments conducted on chicks exposed to a sublethal level of irradiation and then injected with DNA from special stock of birds showing frizzled plumage, creast, feathered shanks, polydactyly, naked neck, silkie, and muff did not yield positive results. No evidence of induced phenotyic change was evident in the hosts nor in their progeny. Similarly, DNA transplants designed to detect a possible change in the antigenic structure of the blood group systems also failed to show any evidence of genetic transformation. From this it was concluded that irradiated host cells could not utilize foreign sequentially arranged nucleotides bearing genetic expression. The data of in vitro studies indicate that erythrocytes of chicken are able to absorb heterologous, homologous and autologous DNA and the absorption was 15.59% of the normal DNA complement regard-

less of the sources. There was no DNA absorption when the cells were exposed to calf thymus DNA that was denatured by heating it to 100°C for 20 min. There was no evidence of the passage of DNA out of the erythrocytes once it was absorbed. (Diss. Abstr.)

43806 DISTURBANCES OF ELECTROLYTE AND WATER BALANCE IN ACUTE RADIATION DAMAGE. Hallauer, W.; Schirmeister, J. (Univ., Freiburg i. B.). pp 35-43 of Informationstagung der Gesellschaft fuer Strahlenforschung m.b.H. und der Vereinigung Deutscher Strahlenschutzaerzte e.V. in Freiburg i. Br., 26 and 27 October 1966. Fliedner, T. M.; Hauger, W. (eds.). Stuttgart, George Thieme Verlag, 1967. (In German).

The sequence of development of gastrointestinal symptoms observed after irradiation with 100 to 1000 R was described and discussed. The extreme changes caused by loss of water, electrolytes, and protein, which resulted in death from hypovolemic shock were described. The pathogenesis of the gastrointestinal syndrome, net transfers and losses of electrolytes and water after exposure of rats to irradiation doses of up to 2500 or 3000 R, characteristics of electrolyte and water balance in plasma, liver, muscle, and connective tissue and values of hematocrit, Na^+, K^+, Cl^-, plasma H_2O, and CO_2 binding capacity were discussed. Treatment of the gastrointestinal radiation syndrome, based on compensation for losses in water, plasma, blood, and electrolytes was discussed. Effects of treatment with electrolytes, glucose, and antibiotics on survival of rats after abdominal irradiation with doses of 1000 R were studied. Combined treatment with electrolytes and antibiotics decreased mortality from 100 down to 14%. Average survival times were increased from a control value of 3.8 to 8.2 days by this treatment. (BBB)

Radiodiagnosis

Refer also to abstracts 43553, 43659, 43683, 43774, 43784, 43796, and 43838.

43807 (COO-1422-58) EVALUATION OF RADIONUCLIDE SOURCES FOR TRANSMISSION SCANNING. Sorenson, James A.; Cameron, John R. (Wisconsin Univ., Madison. Univ. Hospitals). Aug. 1, 1969. Contract AT(11-1)-1422. 24p. (CONF-690624-1). Dep. CFSTI.

From 16th Annual Society of Nuclear Medicine, New Orleans, La.

Transmission imaging using scanning and counting techniques was developed as a method of obtaining anatomic information for accurate keying of radionuclide emission images obtained on a rectilinear scanner. Techniques have also been developed for transmission imaging with a scintillation camera. Transmission images have been reported to be of value for outlining air spaces and organs in the chest for the interpretation of lung and heart scans, and for outlining bony structures in the head and the pelvis for the interpretation of brain scans and bone scans, respectively. Various radionuclide sources have been used for obtaining transmission images on rectilinear scanners and scintillation cameras, principally ^{125}I (30 keV), ^{241}Am (60 keV), and ^{99m}Tc (140 keV). Of these, only ^{99m}Tc has been shown to be useful for scintillation camera studies, primarily because of the loss of spatial resolution with this device at lower photon energies. Rectilinear scanners do not have this limitation, and consequently any of the above mentioned sources and a variety of others are potentially useful for transmission imaging with a scanner. An evaluation is presented of a number of transmission scanning sources for various transmission imaging procedures. (C.H.)

43808 (NYO-3442-15) SELECTIVE ISOTOPIC LABELING OF THE PARATHYROID GLAND. Progress Report, September 1965-June 1966. Potchen, E. James (Peter Bent Brigham Hospital, Boston, Mass.). Contract AT(30-1)-3442. 25p. Dep. CFSTI.

A technique was developed for the reliable surgical extirpation of rat parathyroid glands using ^{125}I and ^{75}Se as a double isotope label and microdissection methods. An ultramicro method for N determination permitted the quantitative assessment of the ^{75}Se specific activity in parathyroid tissues. The uptake of ^{75}Se by the parathyroid gland in the blood plasma and parathyroid and thyroid glands of rats at various times following injection was measured. Thyroxin pretreatment had no effect on parathyroid uptake of ^{75}Se at the dose levels and times investigated. A low Ca diet for 21 days resulted in a 2.3 fold increase in ^{75}Se uptake by rat parathyroid four hours following injection. Thyroxin pretreatment did not influence this effect of dietary Ca. Thyroid ^{75}Se uptake was markedly enhanced by thyrotropic hormone treatment. Control mechanisms of thyroid and parathyroid protein synthesis were studied in vitro using ^{75}Se as a tracer. Selenium-75 parathyroid scans on 40 patients who underwent surgery for hyperparathyroidism were evaluated. The method was of value in the preoperative localization of abnormal parathyroid activity but did not aid in the diagnosis of hyperparathyroidism. (C.H.)

43809 (TT-67-56003/6) POLISH REVIEW OF RADIOLOGY AND NUCLEAR MEDICINE. Translated reprint of Pol. Przegl. Radiol. Med. Nukl., 31: 773-911(1967). 138p. CFSTI.

Separate abstracts were prepared for four papers. Thirteen additional papers discuss applications of radiography in the diagnosis of various pathological conditions. (C.H.)

For abstracts of individual papers see: 43650, 43760, 43826, and 43827.

43810 USE OF RADIONUCLIDES IN THE DIAGNOSIS OF TUMORS. Oeff, Karl (Freie Univ., Berlin). Deut. Med. J., 18: 689-93(Dec. 5, 1967). (In German).

Various uses of ^{99m}Tc in tumor diagnosis are discussed briefly. These included the role of ^{99m}Tc in thyroid scintigraphy, which was estimated to reduce irradiation exposure by a factor of 200, as compared to ^{131}I. The active uptake of ^{99m}Tc by salivary glands is discussed. Because of its surface deposition, ^{99m}Tc was particularly advantageous for detection of small tumors and cold nodes. For detection of tumors in the gastric mucosa ^{99m}Tc has been shown to be superior to ^{131}I. Complexes of ^{99m}Tc with Fe have been shown to be selectively deposited in the renal parenchyma. By this means ^{99m}Tc has advantages for detection of renal tumors, cysts, and abscesses which have replaced or endangered the normal tissues, since in these disease states the ^{99m}Tc may not be taken up as much as in the normal renal parenchyma. However, the detectability of these defects with ^{99m}Tc has been limited by instrument sensitivity. (BBB)

43811 SALIVARY GLAND SCINTI-SCANNING WITH ^{99m}Tc PERTECHNETATE. Abramson, Allan L.; Levy, Lester M.; Goodman, Merrill; Attie, Joseph N. (Long Island Jewish Hospital, New Hyde Park, N. Y.). Laryngoscope, 79: 1105-17(June 1969).

Normal and abnormal salivary gland scinti-scans with ^{99m}Tc were correlated with histologic and clinical data. One mCi of ^{99m}Tc in the pertechnetate form was injected intravenously during the first half of this study whereas 2 mCi was used during the latter half, resulting in a higher radioactive count rate and better tissue definition. Scinti-scanning was started 30 min after injection in the following sequence: Lateral view of affected side—parotid area to lip, including the submaxillary region; lateral view of the normal side; and anterior view. Scanning time averaged 20 min. Photoscans and color scans were obtained simultaneously. The lateral face scans were obtained using a 3-in. fine-focus, 163-hole collimator placed 2½ in. above the surface of the parotid. Anterior scanning was done with a 5-in., 265-hole collimator placed 5 in. above the imaginary center of the parotid. Prominent facial landmarks and palpable limits of abnormal salivary glands were marked on the scinti-scans as reference points. The maximum cpm values were noted prior to the start of scanning over the normal and abnormal areas of the parotid. When the count rate was above 5000 cpm, the speed of the scanner was set at 44 cm/min; when the rate was below this, the setting was 24 cm/min. Some surgical specimens were scanned and quantitative radioactivity measurements taken. Anterior scans often showed decreased activity over the parotid and submaxillary areas, probably representing rapid discharge of Tc into the mouth. Some salivary gland tumors displayed increased, and others decreased concentration of ^{99m}Tc-pertechnetate. (BBB)

43812 THE CLINICAL VALUE OF ^{99m}Tc SCANNING AFTER RENAL ALLOTRANSPLANTATION. Barnes, A. D.; Beeley, L.; Drolc, Z.; Hobby, J. A. E.; Edwards, P. Dawson (Queen Elizabeth Hospital, Birmingham, Eng.). Lancet, 1: 1293-4(June 28, 1969).

A simple isotope scanning procedure was developed for evaluating renal function in the initial anuric phase after renal transplantation in man. Sodium pertechnetate-^{99m}Tc was prepared 30 min before use by washing a ^{99}Mo column with isotonic saline. Scanning which took 20 min commenced within 5 min of an intravenous injection of 1 mCi of the isotope. The patients were scanned with a 5-in. crystal rectilinear scintiscanner with a 3-in. focused coarse collimator. (Speed of scan was 110—130 cm/min, and line-spacing 0.4 cm). Eight patients, anuric after renal transplantation, were scanned within the first four postoperative days, and on one or more occasions later during and after the period of anuria. The transplanted kidney was outlined as an area of high activity in seven of the patients and all started to produce urine within four weeks. After administration of the isotope, normal kidneys in the anatomical position are not demonstrated by an abdominal scan; but kidneys transplanted to the iliac fossa, whether they are anuric or functioning, consistently show high activity on a scan provided that their blood supplies are intact. (BBB)

43813 LOCALIZATION OF THE PLACENTA BY RADIOISOTOPE PHOTOSCANNING USING ^{99m}Tc-LABELED ALBUMIN.

Moestrup, J. K.; Frederiksen, P. Buechler; Munk, J.; Madsen, W. Sondergaard (Odense County and City Hospital, Denmark). Acta Obstet. Gynecol. Scand., 48: Suppl. 3, 164-7(1969).

By the use of ^{99m}Tc-labeled albumin, the placenta was visualized by photoscanning in 27 patients in the third trimester of pregnancy. Examples of the photoscans obtained are illustrated. The ^{99m}Tc-labeled albumin was prepared using a modification of the method outlined by McAfee et al. The scanning procedure was carried out using the Picker Magna Scanner. Total radiation exposure to the fetus was found to be less than 16 mrad. The method is of value in the management of patients with third trimester bleedings and before amniocentesis. (BBB)

43814 APPLICATION OF LOW-ENERGY GAMMA-SOURCES IN CLINICAL DIAGNOSTICS IN THE HUNGARIAN PEOPLE'S REPUBLIC. Horvath, M. (Balatonfuered, Szivkorhaz, Hungary); Foeldes, J.; Kocsis, S. Atomtech. Tajek., 11: 671-6(Dec. 1968). (In Hungarian).

Preliminary experiments with animals, radiochemical determinations, and calibration of instruments preceded the application of low-energy gamma irradiators. Applications of ^{197}Hg for kidney scanning, ^{125}I and ^{99}Tc for thyroid scanning, and ^{133}Xe for cardiopulmonary diagnosis are described. Indium-115 was used for kidney, liver, and spleen scanning. (auth) (TSS)

43815 THE YEAR BOOK OF RADIOLOGY, 1969. Holt, John Floyd; Whitehouse, Walter M.; LaTourette, Howard B. (eds.). The Practical Medicine Year Books. Chicago, Year Book Medical Publishers, 1969. 463p. $14.00.

Separate abstracts were prepared on the two sections of this book. The first section deals with radiologic diagnosis, and the second with radiotherapy. References to current journal literature are given in the form of footnotes. Subject and author indexes are included at the back of the book. (E.R.B.)

For abstracts of individual sections see: 43816 and 43832.

43816 RADIOLOGIC DIAGNOSIS. Holt, John Floyd; Whitehouse, Walter M. (eds.). pp 5-269 of The Year Book of Radiology, 1969. Holt, John Floyd; Whitehouse, Walter M., LaTourette, Howard B. (eds.). Chicago, Year Book Medical Publishers, 1969.

Part one of the two part 1969 Yearbook of Radiology reviews the current literature in the field of diagnostic radiology. Included in the section are discussions of the technical developments in radiographic diagnosis, instrumentation, and procedures; technical advances in angiography; and radiographic techniques for diagnosing diseases and malformations of the head and neck, the spine and extremities, the chest (including mammary glands), the gastrointestinal tract, and the genitourinary tract. References to current journal articles are presented throughout the section in the form of footnotes. (E.R.B.)

43817 SCANNING OF THE THYROID GLAND WITH THE AID OF ^{99m}Tc PERTECHNETATE. Kotlyarov, E. V.; Kovalchuk, N. D.; Tarasov, N. F. (Moscow Inst. of Medicine). Med. Radiol., 14: No. 6, 33-7(June 1969). (In Russian).

The accumulating function of the thyroid gland was investigated in 54 patients. In 43 patients scanning was carried out both with ^{99m}Tc-pertechnetate and ^{131}I. Scanning was effected 1½ hr after peroral ingestion of 1500 to 2000 μCi of ^{99m}Tc-pertechnetate. Radioiodine scanning was carried out 24 hr after peroral ingestion of 50 μCi of the isotope. The quality of scannograms was assessed by the ratio of dot scan density in the thyroid tissue and that in the region of soft tissues of the neck. Scannograms performed with ^{99m}Tc were not inferior to scannograms with ^{131}I, whereas in patients with hypothyrosis they considerably surpassed it. The nature of changes recorded on scannograms with ^{99m}Tc corresponded to that in the use of ^{131}I and had no distinguishing features. (auth)

43818 DIAGNOSTIC IMPORTANCE OF COLOR SCANNING IN CERTAIN DISEASES OF THE KIDNEYS. Zubovskii, G. A.; Gleizer, Yu. Ya. (Central Research Inst. of Roentgenology and Radiology, Moscow). Med. Radiol., 14: No. 6, 29-33(June 1969). (In Russian).

After years of experience with the Hungarian scanner Scinticart, it was concluded that the new model of the Soviet gammatopography-2 has a number of advantages—the presence of a focus collimator and the possibility of color registration. It is possible to determine the true size of the kidneys. Two-color scanning enables detailed evaluation of changes in the parenchyma of each kidney. Comparison of data obtained by means of black-white scanning with the results of color registration, demonstrates the advantages of color scanning. (auth)

43819 RADIATION PAROTIDOPATHY. II. RADIOBIOLOGICAL AND CLINICAL CONSIDERATIONS. Sassi, P.; Cecchetti, E. (Univ., Bologna). Oto-Rino-Laringol. Ital, 36: 268-93 (1967). (In Italian).

The work submits radiological evaluations (for which they refer to a previous note) as well as clinical and anatomo pathological ones. After a review of the various biological parameters to explain the variety of the individual effects of irradiation, they take into consideration, as a function of the physical parameters, the pictures of parotid suffering seen in patients submitted to ionizing radiations of different energetic levels and studied at different doses as well as at different time intervals after radiotherapy. After having described the pictures characterizing, due to their significant frequency, some of the doses and evolutive moments of suffering in the irradiated parotid (edema, increased permeability of contrast medium, sialodochitis and parotiditis, scleroatrophy) the authors conclude ascribing a prominent importance to the dose, the time elapsed since irradiation, and the condition of the gland before the radiological treatment. The authors, then, after having stressed the importance of the sialographic examination, state that the radiological research is the means which offers the highest quantity of data on the condition of the excretory channels and the volume of the parotid. (auth)

43820 PRECORDIAL-COUNTING: EVALUATION AND COMPARISON OF ^{131}I LABELED ALBUMIN AND ^{99m}Tc IN DETECTION OF LEFT-TO-RIGHT SHUNTS. Lorimer, A. R.; McCall, D.; Boyd, G. (Glasgow Royal Infirmary). Thorax, 24: 348-52(May 1969).

Methods of precordial counting of ^{99m}Tc and ^{131}I in the detection of left-to-right intracardiac shunts were presented. Both ^{131}I-labeled albumin and ^{99m}Tc were used but ^{99m}Tc was preferred, especially for children, since it has a short physical half-life and emits a single γ ray. Normal values and those in patients who had either rheumatic or congenital heart disease were established. All left-to-right shunts were confirmed at cardiac catheterization. False-negative results were rare but false-positive results occurred in the presence of congestive cardiac failure with ^{99m}Tc. It was possible to detect left-to-right shunts with a pulmonary-to-systemic flow ratio as low as 1.2:1. An estimate of this ratio was made from the precordial curve. The main value of the ^{99m}Tc method was as a preliminary investigation in the detection of intracardiac shunts. (BBB)

43821 LUNG SCANS FOLLOWING INHALATION OF NEBULIZED RADIONUCLIDES. Haynie, Thomas P. (Univ. of Texas, Houston). J. Asthma Res., 5: 231-40(June 1968).

Different isotopes and techniques were used for the performance of inhalation lung scans (ILS), and observations concerning their value in the study of patients with pulmonary disorders are reported. The 4 different radiopharmaceuticals used were prepared as follows. Albumin-^{131}I was made up in a 6% solution with a concentration of ~500 μCi ^{131}I per ml. Technetium-99m-labeled albumin was prepared using pertechnetate obtained from an isotope generator. The isotope was mixed with $FeCl_3-6H_2O$ and ascorbic acid and added to human serum albumin under pH control. Technetium-99m-labeled colloid was prepared using antimony sulfide obtained by the classical procedure. A positive pressure breathing device was fitted with a standard nebulizer cup. The outflow valve led to a balloon where the exhaled radioactivity was collected. Initial scans with ^{131}I-albumin, delivered by intermittent positive pressure breathing, were satisfactory in a few patients. Difficulties were encountered with the time necessary to deliver the necessary amount of radioactivity (30 to 60 min) and the low count rates obtained (2500 cpm). Technetium-99m-albumin overcame the difficulties of the low count rate because the short half-life permitted higher activities of isotope (up to 10 mCi). With inhalation times of 30 min, count rates of up to 15,000 were obtained over the lungs. Technetium-labeled albumin proved irritating to most of the patients. The preparation of ^{99m}Tc-labeled colloid proved to be simpler than that of Tc-labeled albumin, and the material was less irritating to patients. It provided the best method of those tested. (BBB)

43822 LYMPHATIC SCINTIGRAPHY IN TUMOR THERAPY (STUDIES ON MORE THAN 800 TUMOR PATIENTS). Breit, Alfred; Czempiel, Heinz; Koernig-Kron, Karin (Staedtische Krankenhauses, Passau, Ger. Staedtische Krankehauses, Munich). Strahlentherapie, 138: 74-84(July 1969). (In German).

A radioactive lymphoscintigraphy was obtained in 597 patients with biopsy proven cancer. The reliability of this simple examination method is outlined. The scintigraphy is compared to the lymphogram, the clinical evolution, and with the surgical specimen. (auth)

43823 INVESTIGATION OF INCREASED ^{131}I UPTAKE BY THE THYROID GLAND WITHOUT HYPERFUNCTION. Grebe, Siegfried Franz (Justus-Liebig-Univ., Giessen, Ger.). Strahlentherapie, 138: 85-94(July 1969). (In German).

When in the double-phase test, a high uptake of iodine by the thyroid is found, without any clinical sign of hyperfunction, this

is invariably due to an important decrease of the renal iodide clearance. In many cases an increased active and functional volume is observed, as in goiters. The ^{131}I dynamics occur because of the increased reserve in iodide in the thyroid, that dilutes the ^{131}I. The values for the total and ^{131}Pb are many times very low. Hyperthyroidism could in this way be masked by the normal values. Some cases show, when the test is repeated, variable results, but rarely an hyperthyroidism. One can in case of an increased iodine uptake think of a preliminary phase of hyperthyroidism. (auth)

43824 DIAGNOSTIC VALUE OF SCINTILLATION BRAIN-SCANNING. Forster, D. M. C.; Bethell, A. N. (Royal Infirmary, Sheffield, Eng.). Clin. Radiol., 20: 257-68(July 1969).

The results of 361 consecutive brain scans carried out with isotopes of mercury and technetium are reviewed. The choice of isotopes and the techniques used are outlined and the clinical value of the results are discussed. Some features of a scan which may be helpful in suggesting the underlying pathology are described. The scans were positive in 149 cases, negative in 115, and equivocal in the remaining 97. The pathology was established at operation or autopsy in 144 cases. About 75% of the scans gave convincing positive or negative results and less than 4% were misleading. It is concluded that brain scanning is a reliable ancillary investigation even when staff and equipment are limited. The investigation is safe, involves little discomfort to the patient and can be performed on an out-patient basis. (auth)

Radiotherapy

Refer also to abstracts 43688, 43701, 43722, 43769, 43777, 43799, 43815, 43851, 43876, 43886, 43889, 43894, 43897, 43898, 43899, 43902, 43905, and 43923.

43825 (NSJ-tr-106) THE PRESENT STATUS OF RADIOTHERAPEUTICS IN JAPAN. Kusumoto, Goro. Translated from Genshiryoku Chosa Kiho, No. 10, 13-17(Dec. 1965). 9p. Dep.

Since radiotherapy is applied mainly to the treatment of malignant tumors, descriptions are given of the present status of radiotherapeutics in Japan, with regard to malignant tumors. According to the results of investigations of the medical uses of radioisotopes in the fiscal year 1963, by the Atomic Energy Bureau, the radiotherapeutic apparatuses, used in Japan in the fiscal year, totalled 231, and the amount of radioisotopes was a total of 161,872 curies. At the present time, the number of medical linear accelerators and of betatrons are 3 and 7, respectively. Descriptions are made in the following sections: introduction (radiotherapeutic methods for malignant tumors, principles of radiotherapy, and progress in radiotherapeutic apparatuses and equipment), the present status of radiotherapy in Japan (the uses of radiotherapeutic instruments, and the techniques of radiotherapeutics), the future prospects of radiotherapeutics, and conclusion. (auth)

43826 (TT-67-56003/6, pp 830-4) IMPORTANCE OF BEAM CENTERING IN THE ROTATION TECHNIQUE. Szymczyk, Wieslawa; Siuda, Jerzy; Drejak, Zdzislaw. Translated from Pol. Przegl. Radiol. Med. Nukl., 31: (1967).

Accurate knowledge of the position of the axis of rotation and constancy of this position during movements of the Roentgen tube are of fundamental importance in therapy by the rotation technique. The Siemens Stabilipan rotation apparatus is equipped with the following lights for verification of centering of the beam: axial determining the axis of rotation; two lateral lights determining the radius of rotation; and a light beam corresponding to the x-ray beam. After many years' operation of the apparatus, mainly under stationary conditions, discrepancies of the centering lights were observed, which were attributable to mechanical defects such as loosening, bending, and displacement of the construction holding the tube. The harmfulness of such defects is discussed. (auth)

43827 (TT-67-56003/6, pp 842-6) RESULTS OF IRRADIATION THERAPY OF TUMORS OF THE LYMPHATIC SYSTEM. Glinska, Halina; Skolyszewski, Jan. Translated from Pol. Przegl. Radiol. Med. Nukl., 31: (1967).

An analysis of therapeutic results in cases of tumors of the lymphatic system is presented, with special reference to failures of radiation therapy in relation to the morphologic form of the tumor. The total of 305 patients included 182 with lymphogranulomatosis, 103 with reticulosarcoma, and 20 with lymphosarcoma. In all cases, the clinical diagnosis was confirmed histologically. The patients were divided clinically into a group with unadvanced lesions involving one or two lymph node regions, and a group with advanced lesions with more extensive involvement of lymph node groups, or with coexisting systemic symptoms. Analysis of the results led to the conclusion that the probability of five-year survival in patients with reticulosarcoma is smaller than in patients with lymphogranulomatosis or lymphosarcoma. On the other hand, clinical cure, i.e., five-year survival without tumor symptoms, was equally frequent in all morphologic forms of tumors of the lymphatic system, amounting to 20% of patients treated radically with x radiation. The higher percentage of local recurrences in reticulosarcoma compared with lymphogranulomatosis and lymphosarcoma indicates lesser radiosensitivity of lymphatic tumors of this type. (auth)

43828 NEUTRONS INDUCED BY TELETHERAPY BETATRON. Noda, Hiroji (Kurume Univ., Japan). Fukuoka Igaku Zasshi, 59: 582-8(Sept. 1968). (In Japanese).

Irradiation with high energy photons and electrons in excess of 8 MeV induced photoneutrons by (γ,n) reaction. A water phantom was irradiated by x rays and an electron beam of 31 MeV teletherapy betatron. The distribution of thermal neutron flux was determined by means of the gold foil activation method. Energies of photons and electrons, filters, and scattering material were varied during the study. The distribution curve of thermal neutron flux density in the phantom changed according to the conditions, such as kind of radiation, quality of radiation, and kind and thickness of filter. However, maximum flux density was observed at 4 to 5 cm depth, and at greater than maximum depth the flux densities decreased exponentially. Both of these findings were unrelated to variation of exposure factors. In the case of photon radiation of 29 MV the additional neutron dose was about 0.3%. But the amount of induced neutrons increased according to accelerating voltage increase. Therefore the hazard by induced neutrons should be considered for higher accelerating energies. (NSA of Japan)

43829 TREATMENT OF HYPERTHYROIDISM FROM THE AUTONOMOUS MULTINODULAR GOITER. Miller, J. Martin; Weber, Richard E.; Block, Melvin A. (Henry Ford Hospital, Detroit). Henry Ford Hosp. Med. J., 15: 85-92(Summer 1967).

Use of radioiodine to treat 21 patients with multinodular goiter is compared with that of surgery, and the complications and hazards of ^{131}I therapy are assessed. Ten patients were made euthyroid by a single dose of ^{131}I and 10 others required two doses. The patients who became euthyroid following a single dose did so in from two to four months. Those requiring retreatment received the second dose between three and six months after the first and became euthyroid in a total of six to 15 months (average 8.7). Seven patients were given thyrotropin (TSH) before the second therapy since the average uptake at this time was only 11%. Morbidity in this group consisted of a moderately severe radiation thyroiditis, mild obstructive symptoms from 20 units of TSH in a patient with retromanubrial goiter, a probable mild exacerbation of the disease with nausea and vomiting, and a posttreatment psychosis. (BBB) (TSS)

43830 FOUR CASES OF LYMPHOID LEUKEMIA TREATED BY EXTRACORPOREAL IRRADIATION OF THE BLOOD. Garrett, J. V.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nouv. Rev. Franc. Hematol., 8: 701-7(Sept.-Oct. 1968). (In French).

Four male patients with late chronic lymphatic leukemia were treated by extracorporeal irradiation of the blood using a ^{90}Sr irradiator. Survival time varied from 1 to 11 months, but two of the patients died of causes other than leukemia. In all cases, the course of irradiation produced reduction in the lymphocyte count and usually also in the size of the spleen and lymph nodes. After irradiation, the lymphocyte count rose slowly towards its pre-irradiation level. The transit dose of the device used was 326 rad, and it was estimated that 90% of the lymphocytes were killed in each passage of blood through the coil. The total blood dose received was estimated to be from 18,000 to 35,000 rad. Some implications of the findings in relation to lymphocyte kinetics are discussed. (BBB)

43831 CONTROLLED CLINICAL TRIALS IN RADIOTHERAPY. Deeley, Thomas J. (Hammersmith Hospital, London). Radiography, 35: 65-70(Mar. 1969).

The use of controlled clinical trials to evaluate new radiotherapy techniques and radiations (such as hyperbaric oxygen and neutron therapy), and to determine the effectiveness of different dose schedules and levels, is explained. An example of evaluating the effectiveness of 2 different dose levels is cited. With the introduction of supervoltage apparatus it is possible to give high doses of radiation to all sites in the body. Future progress will be made by the more effective use of these supervoltage machines. Attempts must be made to resolve some problems in radiotherapy, to rationalize radiation techniques, and to determine which methods give the best results. For each type of tumor it is necessary to know the opti-

mum tumor dose, treatment time, and methods of fractionation that give the best survival rates and least morbidity. Other problems need to be elucidated: for example, whether oxygen therapy gives improved results over conventional treatment in air, the value of neutron therapy, and value of additive chemotherapeutic agents. Collection of data and use of a punched card system are outlined. An example of a clinical trial in which the system and patient pairing was used was designed to determine whether a dose of 3000 rad or 4000 rad gave better results for advanced anaplastic carcinoma of the bronchus. The patients were all treated by a linear accelerator using 2 nonopposed wedged fields. The average duration of life of patients treated with 3000 rad was 9.3 months and with 4000 rad was 6.0 months. These results are significant at the 5% level. There was an increase in the incidence of radiation fibrosis in patients receiving 4000 rad. (BBB)

43832 RADIATION THERAPY. LaTourette, Howard B. (ed.). pp 271-443 of The Year Book of Radiology, 1969. Holt, John Floyd; Whitehouse, Walter M.; LaTourette, Howard B. (eds.). Chicago, Year Book Medical Publishers, 1969.

Part two of the two part 1969 Yearbook of Radiology presents a review of the current journal literature in the field of radiotherapy. Following a brief introduction and a general discussion of the field of radiotherapy, individual chapters are devoted to the discussion of therapy of diseases and malformations of; the head and neck, the chest (including mammary glands), the gastrointestinal and genitourinary tracts, gynecologic conditions, etc. A separate chapter is devoted to the radiotherapy of lymphomas. The last five chapters in the section discuss radiotherapy from the standpoint of the interaction of radiation with biological materials. This discussion includes radiobiology, radiation effects, treatment techniques and planning, the use of radioisotopes in therapy, and radiation control and hazards. (E.R.B.)

43833 TISSUE ACTIVATION STUDIES WITH α-PARTICLE BEAMS. Maccabee, H. D.; Madhvanath, U.; Raju, M. R. (Univ. of California, Berkeley). Phys. Med. Biol., 14: 213-24(Apr. 1969).

The positron-emitting activation of tissue by α-particle beams was studied, using the annihilation γ-ray coincidence detection technique and the Anger positron camera. The decay spectrum in tissue following irradiation by 53 MeV α-particles from the Berkeley 88-inch cyclotron was measured, as well as a visualization of the activation pattern resulting from a 910 MeV α-particle beam stopping in a tissue-like plastic phantom, at the Berkeley 184-inch synchrocyclotron. Also studied were the activation patterns resulting from transmission of 910 MeV α-beams through a wax head phantom, and the activation pattern in patients' heads resulting from sittings for the pituitary ablation therapy technique. With slight improvements in resolution and sensitivity, an on-line positron camera technique could be useful for alignment of the end of the beam track in Bragg-peak therapy with heavy charged particles. There are other novel applications which might be possible, using tissue activation techniques. (auth) (UK)

43834 HISTOPATHOLOGICAL STUDIES OF THE EFFECT OF ONE-MASS-DOSE BETATRON ELECTRON IRRADIATION ON CERVICAL CANCER, WITH EMPHASIS ON THE POSSIBILITY OF APPLYING IRRADIATION DURING OPERATION. Koide, Yasuji (Tokyo Univ. Hospital). Acta Obstet. Gynaecol. Jap., 16: 17-33(Jan. 1969).

Radiosensitivity of cervical cancer and histologic effects of β irradiation were followed after early-stage cervical cancer patients were irradiated with a betatron in one dose prior to operation. A biopsy was taken daily for 1 to 2 weeks, until radical hysterectomy was performed, and after operation histological specimens taken from the extirpated uterus were examined. Feasibility of direct-view irradiation with electrons during operation was assessed. Radiation effects increased with irradiation dose. Electron irradiation in one dose of 4000 rad proved effective in 62.5%. In most cases of the "effective" group (in which cancer cells were not seen in the operated uterus), viable cells had disappeared from biopsy specimens by 15 days after irradiation. Even if cancer cells still existed in the extirpated material after irradiation, their disappearance within 2 weeks of irradiation was probable. Radiation effect was closely related to the size of the tumor. Good results cannot be expected through irradiation in 1 dose when the tumor is as large as 2×2 cm. Radiation effect apparently is also related to the maturity of cancer tissue. In the case of squamous epithelial carcinoma, nonkeratotic cancerous cells tended to respond more to irradiation than parakeratotic and keratotic cancer cells. For cases which showed positive stromal reactions prior to irradiation, the radiation effect was found to increase more significantly with dose than for those which showed negative stromal reactions. In the stromal cellular response, small round cells and plasma cells showed a sharp decrease 1 week after irradiation, but thereafter increased with time. On the other hand, neutrophils attained a peak 1 to 2 weeks after irradiation and thereafter decreased. Disturbances in normal tissue due to electron irradiation in 1 dose was studied clinically as well as by animal experiments. No marked pathology such as ulcers or necrosis was observed. (BBB)

43835 APPLICATION OF PENDULUM RADIATION FOR DEPTH THERAPY WITH FAST ELECTRONS. Heuss, Kurt; Hoeffken, Walther (Allgemeinen Ortskrankenkasse, Cologne). Strahlentherapie, 138: 40-9(July 1969). (In German).

The 42 MeV betatron from Siemens allows arc therapy of deep seated tumors with high energy electrons. The dose distribution of rotation and arc irradiation obtained by 42 MeV electrons, 40 MV x rays, and ^{60}Co γ rays were compared and discussed. The special advantage of using electrons in arc therapy is sparing of tissues close to the tumor. By changing the energy of the electrons, oscillation angle, centering depth, and field width, dose distribution can be adapted to each shape of tumor bed. Isodose plans are given for arc therapy of bronchus carcinoma, rectum carcinoma, and kidney post operational. (auth)

43836 X-RADIATION AS A TREATMENT OF INFLAMMATORY CONSTRICTION FOLLOWING GASTRO-ENTERO ANASTOMOSES. Frank, Andreas (Krankenanstalt Rudolfstiftung, Vienna). Strahlentherapie, 138: 32-8(July 1969). (In German).

Possibilities of postoperative roentgentherapy are outlined in the cases of inflammation of a gastro-enteric anastomosis. The technique of this treatment is described and the results are discussed in view of some observations. The very complex mechanism of the antiphlogistic radiotherapy is discussed. (auth)

43837 EFFICACY OF HIGH DOSES OF ^{60}Co γ IRRADIATION IN ADVANCED CARCINOMA OF CERVIX AND VAGINA. Claus, Hans-Guenther; Diethelm, Lothar; Martin, Konstantin; Strauss, Guenther (Johannes-Gutenberg-Univ., Mainz). Strahlentherapie, 138: 15-26(July 1969). (In German).

The results and complications observed, between 1961 and 1968, after telecobalt therapy in 67 advanced cases of carcinoma of the uterine cervix and in six advanced cases of vaginal carcinoma are reported. Previously, the static field method was applied, but was soon replaced by the biaxial pendular rotation therapy. In the same time the dose of 6000 R was increased to 8000 R. The basic principles underlying this technique are explained. Among the reactions observed, procto-sigmoiditis was the most frequent. The good primary results and the survival of a few patients encourages continuation in the same way. The basic indication remains the same: homogeneous pelvic irradiation is practiced only in advanced cases where radium has nothing to offer. (auth)

43838 INVESTIGATION OF THE PHYSICAL PRINCIPLES UNDERLYING THE PROJECTION-GRID RADIATION. Rode, Ivan; Bozoky, Laszlo (Onkologische Landesinstitut, Budapest). Strahlentherapie, 138: 95-100(July 1969). (In German).

An extensive study of the physical basis of radiotherapy through grids lead to the determination of the basic parameters of a grid for telecobalt: the surface and the dose-intensity in the inhomogeneously irradiated grid-openings and also the optimal characteristics of a telecobalt-grid. The grid developed earlier was modified, based on these theoretical studies, so the dose-intensity was doubled. (auth)

43839 COMPLICATIONS DURING PRIMARY RADIATION THERAPY OF CARCINOMAS INVOLVING THE FEMALE GENITAL TRACT. Weghaupt, Karl (Univ., Vienna). Strahlentherapie, 138: 62-73(July 1969). (In German).

Radiotherapy of vaginal, cervical, and corporeal tumors, as practiced at the first gynecology clinic of the University of Vienna is discussed. The overall treatment results are reported and complications are described including: systemic reactions, bone modifications, intestinal and urologic malfunctions, and late modifications in the irradiated skin. These are extensively discussed with their respective treatment. This report is based on the patient material treated between 1950 and 1964, which included 1668 primary irradiated inoperable cancers of the cervix uteri, 122 vaginal tumors, and 345 tumors of the uterine corpus. (auth)

43840 HOMOGENEOUS DOSE DISTRIBUTION IN TELETHERAPY OF MAMMARY CARCINOMAS. Stratev, Ilian; Naumowa, Zwetana; Wrantschewa, Dafina (Onkologische Forschunginstitut, Sofia). Strahlentherapie, 138: 50-8(July 1969). (In German).

A method to obtain a homogeneous dose distribution in the multifield radiation treatment of mammary carcinomas is described. An adaptation of the method to the cone form of the thorax permits

better field positioning. Supplementary fields are then unnecessary. This method can be applied pre- and postoperatively. (auth)

43841 INTERCAPILLARY DISTANCE, OXYGEN TENSION, AND LOCAL RECURRENCE IN CERVIX CANCER. Kolstad, Per (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Scand. J. Clin. Lab. Invest., 22: Suppl. 106, 145-57(1968).

The role of vascularization and consequent cellular oxygen level of cervical cancer cells in radiosensitivity was investigated by colpophotography. Although there are several theories to explain the oxygen effect, there is general agreement that oxygen must be available at the very moment of irradiation to exert its effect, and that only a certain part of the radiosensitivity of a specific biological system is oxygen dependent. Thus, anoxic tumor cells may well be destroyed if the radiation dose is sufficiently large. This probably often occurs in intracavitary radium treatment of cervix cancer. A review is given of attempts to assess to what extent the oxygen tension affects the radiocurability of this tumor. Assessment of the oxygenation of the tumor surface, using the intercapillary distance as parameter, revealed a gradual decrease in the oxygenation with advancing stage of the disease. This was confirmed by direct measurements of the tissue oxygen tension with an open-ended polarographic microelectrode. In invasive carcinoma of the cervix, hypoxic and anoxic foci were frequently encountered. The critical intercapillary instance seemed to be 350 μ, since in cases with greater intercapillary distance the incidence of superficial necrosis rose rapidly. In 51 cases with a largest measured intercapillary distance of more than 400 μ, local recurrence was found in 51.0% during 5-yr follow-up, as compared to 16.7% in 54 cases with intercapillary distance below 400 μ. Out of 10 cases with the lowest observed tumor pO_2 from 0 to 9 mm Hg, 6 had local recurrences in the course of 4 yr, as compared to 4 recurrences among 21 cases with a lowest observed tumor pO_2 above 10 mm Hg. To explain why all tumors with definitely anoxic foci are not radioresistant, it is proposed that only a certain part of the radiosensitivity of a specific tumor is oxygen dependent. The extremely high doses achieved by intracavitary Ra irradiation may destroy anoxic tumor cells in cancer of the cervix. Another factor is the change in microcirculation that may occur during fractionated radiation. It was found that in cervix cancer many tumors develop increasingly better vascularization during fractionated radiation therapy. A corresponding slight increase in tumor oxygen tension was found by polarographic measurements. (BBB)

43842 DEVELOPMENTS IN RADIOTHERAPY WITH SPECIAL REFERENCE TO NEUTRON THERAPY. Greene, David (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Radiography, 35: 79-84(Apr, 1969).

The radiosensitizing effect of oxygen and its exploitation in radiotherapy and new techniques using protons and neutrons are reviewed. Data are shown for the fraction of human cells surviving various doses of radiation: cells in nitrogen irradiated with x rays, cells in air irradiated with x rays, cells in nitrogen irradiated with neutrons, cells in air irradiated with neutrons. The results show that for a given biological effect a much smaller dose is required with neutrons than with x rays. When cells are irradiated with neutrons, the biological effect produced is much less dependent on the presence of oxygen than is the case for x irradiation. This means that neutrons will be much more effective than x rays in destroying the anoxic cells that are known to exist in most tumors. When cells are irradiated with α particles, the biological effects produced by a given dose are the same in oxygen and in nitrogen. The physical parameter that seems to be important in this connection is the way the ionization produced by the particle is distributed at a microscopic level. With x rays the ionizing events are distributed sparsely along the tracks of the secondary electrons, while for α-particle irradiation, the tracks of each particle are made up of closely spaced ionized atoms. The ionization pattern produced by neutrons is intermediate between these extremes. Radiations giving higher track densities than electrons are more efficient than x rays in destroying the cells in the anoxic regions of tumors. The use of negative π mesons for therapy is also discussed. Although π mesons may have desirable properties for radiotherapy, their application to patients is limited by the complex apparatus required for their production. A 14-MeV neutron generator is described that is a relatively simple device, giving beams with depth dose characteristics that are acceptable for radiotherapy. Some depth dose data measured for the neutron beams defined by this apparatus are shown. (BBB)

Blast and Thermal Effects

Refer also to abstract 43789.

43843 ON THE CONGENITAL MALFORMATIONS FOUND IN AUTOPSIES OF HUMAN FETUSES AND NEWBORNS. CUMULATIVE DATA IN THE PAST FIVE YEARS. Okamoto, Naomasa; Ikeda, Takayoshi; Satow, Yukio; (and others) (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 108-12(1969). (In Japanese).

Since this department was established in 1962, autopsies of the fetuses and newborns obtained from the exposed and nonexposed people of Hiroshima have been performed for analyzing the late effects of ionizing radiation. However, it is very difficult to discuss the interrelations between radiation and congenital defects at present. The purpose of this report is to describe the cumulative data of congenital malformations detected at autopsy since the last five years from the pathoanatomical view point. Of 902 corpses of fetuses and newborns, 212 were associated with congenital malformations. Classification of the congenital malformation was made according to their body systems regardless of the multiplicity of defects. As to the result, the total number of congenital malformation was 439 from 212 malformed corpses. They consisted of 119 cases of cardiovascular anomalies, 100 cases of osteomuscular anomalies, 75 cases of urogenital anomalies, 65 cases of the malformation of the central nervous system, 50 cases of the anomalies of the digestive system and 39 cases of other malformations. Apart from the congenital malformations, the variations classified as intermediate between malformation and normal were detected in 284 cases. Other congenital abnormalities such as erythroblastosis fetalis, multiple stomach ulcers and cytomegaly of the adrenal gland were observed in 32 cases. Details are shown in tables attached to the Japanese text. Finally, it is emphasized that the congenital malformations might be a major cause of fetal and neonatal death. (auth)

43844 EPIDEMIOLOGICAL STUDIES OF LEUKEMIA IN NINE TOWNS, HIROSHIMA AND NAGASAKI AREA. Ohkita, Takeshi; Nakanishi, Sumio; Ohara, Kanji; Takahashi, Hiroshi; Sunayashihi, Tadashi; Tomiyasu, Takanori; Ichimaru, Michito. Proc. Res. Inst. Nucl. Med. Biol., No. 10, 133-43(1969). (In Japanese).

The high incidence of human leukemia in 25 towns in Japan was reported through the survey of death certificates during the past five years (1962 to 1966). Six of these 25 towns are located near Hiroshima, such as Kabe, Miyoshi, Toyohama and Yutaka in Hiroshima Prefecture, and Mukaichi in Shimane Prefecture. These facts stimulated further investigations on the incidence of leukemia in these six towns during the past 13 years (1955 to 1967), and the epidemiological studies were reported previously. The results accumulated from investigations on the incidence of leukemia in nine towns, which consisted of these six towns above mentioned, and additional three towns, namely Nishiki in Yamaguchi Prefecture, Kunimi and Mizuho in Nagasaki Prefecture, are reported. The results observed were summarized as follows: The total number of cases was 76 in nine towns and the annual incidence as the highest value during the observed period in each town was from 10.6 to 32.4 per 100,000 population, which was significantly higher than the average incidence of Japan. However, there were great differences in incidence between the first half and the second half of the observed period. In some regions the high incidence in the limited area during a short period was observed. Five of 78 cases were those of atomic bomb survivors. Three of these cases were exposed to the atomic bomb within 2 km from the hypocenter. All cases of atomic bomb survivors occurred before 1962. There were no family relationships among the cases. These results may lead to a speculation that there might be a time and space cluster in the occurrence of human leukemia. But, a more extensive and continuous investigation is necessary to obtain the evidences for cluster formation. (auth)

43845 MEDICAL EXAMINATIONS OF ATOMIC BOMB SURVIVORS IN THE RYUKU ISLANDS. Uchino, Haruto (Hiroshima Univ.); Tsuchimoto, Taiso; Ishida, Sadamu. Proc. Res. Inst. Nucl. Med. Biol., No. 10, 144-7(1969). (In Japanese).

The annual medical examinations of atomic bomb survivors in the Ryuku Islands have been carried out since 1960 by doctors from Hiroshima and Nagasaki Cities sponsored Special Areas Liaison Office, Prime Minister's Office, Japanese Government in cooperation with Ministry of Public Health and Welfare. This report deals with the results of the fifth medical check-up for 18 days, February 25 through March 14, 1969, by us, staffs from Department of Internal Medicine of this Institute and from Hiroshima Atomic Bomb Hospital. The number of registered atomic bomb survivors in the Ryuku Islands, was 265 cases, 128 at Naha district, 52 Chubu, 27 Hokubu, 44 Miyako, and 14 Yaeyama. Out of them, 159 cases were consu'ted and consequently it was found that 106 cases did not have any contributory disorders and 50 cases were diagnosed to have some disorders, though a male patient with advanced hepatic dysfunction was diagnosed to be eligible for the authorization of the delayed effects of atomic

bombing in terms of Medical Care Regulations for atomic bomb survivors. Further discussion was extended to the next examinations and the medical care of atomic bomb survivors in the Ryuku Islands. (auth)

Radiation Effects on Animals

Refer also to abstracts 43686, 43691, 43868, 43915, and 43921.

43846 ENVIRONMENTAL FACTORS IN AGING AND MORTALITY. Strehler, Bernard L. (Veterans Administration Hospital, Baltimore). Environ. Res., 1: 46-88(June 1967).

Following the definitions and background pertinent to a discussion of aging, a categorical analysis of extrinsic factors affecting the rate of aging are discussed and reviewed. Categories considered were physical (radiation and kinetic energy transfer) and chemical sources of disruptive changes; evolved sources of disruption (biological); and possible modification of the rate of aging through manipulation of the internal environment (altered body temperature, dietary restrictions, pharmacological suppression of genetic program, and radiation interference of genetic program). (138 references) (C.O.)

43847 ROLE OF SOME CELLULAR FACTORS IN THE DEVELOPMENT OF ACQUIRED RADIORESISTANCE. Modig, Hans G.; Revesz, Laszlo (Karolinska Institutet Medical School, Stockholm). Atomkernenergie, 14: 214-18(May-June 1969).

In the course of serial intraperitoneal transplantation of an Ehrlich ascites tumor (ELD), the cells were regularly exposed to 2000 R x rays under anoxic conditions before a new transfer. After 23 serial irradiations, six clonal cell populations were established from the serially irradiated cell line (SELD/23) by the isolation of single cells and inoculation into a pre-irradiated new-born mouse. These cell lines together with a tetraploid derivative of ELD, denoted ELT and isolated by immunoselection were studied with regard to their radiosensitivity using either the reproductive integrity in vitro or proliferation capacity in diffusion chambers in vivo as a criterion of sensitivity. Distinct differences in sensitivity of the different cell lines were noted indicating the heterogeneous composition of the serially irradiated tumor. The sensitivity differences were related to the differences in chromosome number, DNA and protein content, and cellular level of nonprotein and protein bound sulphydryl groups. Radioresistance of the cells was found to be associated with either a duplicated chromosome set or an increased cellular content of non-protein bound sulphydryls. (auth)

43848 EFFECT OF TRITIATED THYMIDINE AND 5-BROMODEOXYURIDINE ON DEVELOPMENT OF IMMUNOLOGICALLY COMPETENT LYMPHOCYTES. McGregor, D. D. (Trudeau Research Inst., Saranac Lake, N. Y.). Immunology, 16: 83-90 (Jan. 1969).

Results of experiments in x-irradiated recipient rats suggested that dividing cells in bone marrow can generate lymphocytes capable of initiating a systemic graft-vs-host reaction. In these experiments, Lewis bone marrow cells were incubated in vitro with either ^{3}H-thymidine or 5-bromodeoxyuridine (BUDR), which inhibits cell proliferation. Bone marrow cells prepared in this way and injected into an intermediate (Lewis x DA)F_1 host irradiated with 350 rad were unable to proliferate and mature into circulating immunologically competent lymphocytes. Concentrations of ^{3}H-thymidine and BUDR that inhibited the development of putative lymphocyte precursors in bone marrow had no obvious effect on the immunological performance of thoracic duct lymphocytes. Lewis lymphocytes, cultivated in medium containing these agents, caused a vicious graft-vs-host reaction in x-irradiated (Lewis x BN)F_1 hybrid rats. The results strengthen the view that ^{3}H-thymidine and BUDR exert their inhibitory effect on replicating lymphocyte precursors and not on long-lived members of the circulating lymphocyte pool. The ability of ^{3}H-thymidine (and even high concentrations of ^3H_2O to suppress the formation of immunologically competent lymphocytes) implies that cells of this type are generated from radiosensitive precursors. Presumably, the precursors are members of a replicating cell population normally resident in bone marrow. (BBB)

43849 THE EFFECT OF RADIATION-INDUCED ACTIVE MOLECULES ON RAT THYMOCYTES IN VITRO. Ueno, Akiko (National Inst. of Radiological Sciences, Chiba, Japan). Dobutsugaku Zasshi, 77: 361-3(Nov. 1968). (In Japanese).

It has been previously shown that certain sulfhydryl group (SH)-reactive molecules are formed from some nucleic acid constituents or amino acids by x irradiation (Akita, Ueno and Shima, 1966; Ueno and Akita, 1967). In the present study the survival of unirradiated thymocytes was found to decrease during the incubation in vitro with some nucleosides or histidine that were irradiated previously with γ rays in Ringer solution. When the doses (8 to 204 kR) of irradiation to histidine were increased, the cells died faster. There was, however, always a time lapse of more than 30 min from the beginning of incubation to the first appearance of dead cells. Over the dose-range of 8 to 26 kR, survival was independent of the dose. The addition of cysteine, a thiol protective compound, to the irradiated histidine solution 15 min prior to mixing it with thymocytes suspension abolished completely the cytocoidal effect of the irradiated histidine. On the other hand, the effect was prevented only partially when cysteine was added to thymocytes suspension and then the irradiated histidine solution was added to it 15 min later. These results seemed to suggest that the SH-reactive molecules formed from some nucleosides or amino acids by irradiation played a role in the process leading to the radiation death of thymocytes. (NSA of Japan)

43850 TIME-LAPSE CINEMICROGRAPHIC STUDIES OF X-IRRADIATED HeLa S3 CELLS. I. CELL PROGRESSION AND CELL DISINTEGRATION. Hurwitz, Camilla; Tolmach, L. J. (Washington Univ., St. Louis). Biophys. J., 9: 607-33 (Apr. 1969).

Continuous cinemicrography was used to follow the fate of irradiated cells and to assess quantitatively distortions of the cell generation cycle, cell disintegration, induction of cell fusion and giant-cell formation, and multipolar mitosis. The doses of 220-kV x radiation administered (500, 1000, and 1500 R) enabled few cells to continue to proliferate indefinitely, but substantial numbers of irradiated cells were followed for up to 7 postirradiation generations. The onset of the first mitosis after 500 rad was delayed, as expected from previous studies of the age dependence of mitotic delay. The interval between this first mitosis and the next was indistinguishable from that for unirradiated control cells, while the subsequent 2 generations were again prolonged, on the average, though not so severely as was the irradiated generation. The duration of mitosis was increased proportionally more than interphase. Cell disintegration took place by 2 morphologically distinct processes. Three-quarters of the cells were rounded and apparently trapped in metaphase when they disintegrated; the remaining disintegrations occurred in spread, interphase cells. In cells disintegrating from the rounded configuration, the generation preceding disintegration was prolonged relative to that in cells that divided; in cells disintegrating from either configuration, the penultimate generation was also prolonged. The mitotic times were disproportionately increased in both of these generations. It is suggested that in this system x-ray damage is preferentially expressed as derangement of the mitotic process; such damage ultimately brings about permanent mitotic arrest in most cells. (BBB)

43851 ESTIMATION OF CHANGES IN THE PROPORTIONS AND ABSOLUTE NUMBERS OF HYPOXIC CELLS AFTER IRRADIATION OF TRANSPLANTED C_3H MOUSE MAMMARY TUMOURS. Howes, A. E. (Royal Postgraduate Medical School, London). Brit. J. Radiol., 42: 441-7(June 1969).

Mice bearing transplanted mammary tumors have been irradiated with 250 kVp x rays using a single dose or two fractions. In the latter case the first dose was 1,500 rads given in air and the second dose, whose magnitude was varied, was given either under anoxic conditions or while the animal was breathing air or three atmospheres of oxygen. Analysis was made in terms of the dose required for 50 per cent cure. The results have been interpreted using a model in which the cells surviving the first dose are assumed to be either aerobic or anoxic, and the proportion in each compartment varies with time. On this basis, at one hour after irradiation the hypoxic proportion was increased from 12 per cent to approximately 100 per cent. By six hours, however, the estimated hypoxic proportion had fallen and continued to do so reaching a minimum value at approximately four days after irradiation, this being significantly lower than the pre-irradiation value. Estimates of changes in the total numbers of hypoxic cells indicate that a spacing of 48 hours was probably optimal in obtaining maximal response of these tumors. (auth)

Invertebrates

Refer also to abstracts 43723, 43726, 43727, 43928, 43930, and 43935.

43852 COMPARATIVE STERILITY EFFECTS OF GAMMA RADIATION AND A CHEMOSTERILANT ON DROSOPHILA MELANOGASTER MEIGEN. Nelson, Fred Robert Slater. Amherst, Mass., Univ. of Massachusetts, 1968. 86p.

Thesis.

Laboratory tests were conducted with gamma radiation and a chemosterilant, metepa, to determine dosage levels needed to

induce sterility in Drosophila melanogaster, without adversely affecting the mating potential and longevity. The flies were reared on corn meal-agar medium and propionic acid was added to prevent molds infestation. Usually, only two-day old first generation males and females were selected for these tests. Both irradiated and chemosterilized males were individually offered untreated virgin females on the same day and different females on the third, fifth and seventh day. Each mating period lasted two days and at the end of each period the mating vials were discarded and females were individually placed into oviposition vials with fresh medium. At the termination of each two-day laying period the females were discarded and the oviposition vials held for sixteen days to ascertain the number of offspring emerging from deposited eggs. Males selected for radiation treatments were confined in small gelatin capsules and exposed at dosage levels of 5,000, 12,000 and 15,000 R for 22 minutes, 53 minutes and 66 minutes, respectively. Radiation level at 15,000 R was most effective in inducing sterility in Drosophila. When males were exposed at this level very few offspring emerged. A 12,000 R level was nearly as effective with an average of less than one adult emerged from the treatments. A 5,000 R level was not very effective on the fecundity of Drosophila. The sterilizing dosages of 15,000 and 12,000 R shortened the lifespan of some exposed males. At 5,000 R the longevity of males was unaffected. In the chemosterilization tests, both males and females were exposed together to baits containing 0.25, 0.50, and 1.0 percent concentration metepa for one-day period. At the end of the exposure period the adults were sexed, females were discarded, and the males retained for experimentation. Metepa concentration at 1.0 percent was most effective in inducing sterility. An average of 2.45 adults emerged from the treatments. A 0.50 percent concentration metepa was second best with an average emergence of 10.58 adults. A 0.25 percent metepa concentration did not appreciably affect the fecundity of Drosophila. An average of 23.99 adults emerged from these treatments. None of the three concentration levels of metepa bait used had any deleterious effect on the lifespan of Drosophila males. When males exposed to 1.0 percent metepa bait, were confined at different proportions with untreated male and female the number of offspring decreased as the proportion of treated males increased. Based on the experimental procedures and conditions described in this dissertation, the following conclusions were drawn. Radiation levels approximating 20,000 and 25,000 R adversely altered copulatory behaviour, while no such effect was observed with metepa baits used in concentrations up to 1 percent. Without affecting copulatory behavior radiation levels of 12,000 and 15,000 R effectively reduced laboratory populations of Drosophila melanogaster below the level of economic importance. Similar results were obtained when populations were exposed to 1 percent metepa baits. Radiation levels above 12,000 R had deleterious effect on the longevity of males, but the lifespan of males was not adversely affected by metepa baits when used in concentrations of up to 1 percent. (Disser. Abstr.)

43853 STUDIES ON STRAIN DIFFERENCES IN RADIOSENSITIVITY IN THE SILKWORM, I. SCREENING OF SENSITIVE AND RESISTANT STRAINS TO EMBRYONIC RADIATION KILLING. Murakami, Akio; Tazima, Yataro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 98-100(1967).

Experiments were carried out to select sensitive and resistant strains of silkworms to embryonic radiation killing. Four different dose of x rays, 800, 1,200, 1,600 and 2,000 R, were given the eggs at dose-rate of 250 R/min. After hatching of the surviving embryos, hatchability was calculated and LD_{50} was estimated from dose-response curves. The average LD_{50} for the 30 strains tested was 910 R. There were striking differences among strains with regard to radiosensitivity. The LD_{50} values for the most radioresistant 3 strains were ~1500 R. In contrast, two strains were extremely sensitive, i.e., LD_{50} was 140 R for Ascoli and 240 R for Kojiki. These differences in radiosensitivity might have been, in part, due to different dosages of the relevant genes accumulated in those strains. The radiosensitivity of F_1 eggs was examined in all combinations of diallelic crosses between some resistant and sensitive strains. These eggs were irradiated one day after HCl treatment for artificial hatching. LD_{50} values thus obtained for self-bred batches were almost the same as that observed for over-wintered eggs. In cross-bred batches, however, LD_{50}'s were roughly the same as those observed in inbred batches of the resistant strains. The results suggest that the radiosensitivity of silkworm embryos is controlled by 2 major genes at least, and that the effect of maternal or cytoplasmic factors is relatively small. (BBB)

43854 A CIRCADIAN RHYTHM OF SENSITIVITY OF X IRRADIATION IN DROSOPHILA. Rensing, Ludger (Univ., Goettingen, Ger.). Z. Vergl. Physiol., 62: 214-20(1969). (In German).

A circadian rhythm of sensitivity to whole-body x irradiation was found in female Drosophila melanogaster. The death rates were highest in the morning, and the survival was greatest in the evening. Minima were observed at noon and midnight for death rate and survival, respectively. The artificial light cycle was 12:12 hr, and the whole-body dose was 10,000 R of 150-KV x ray. The death rate maxima were unsymmetrical. The medians of the maxima and minima of survival time were 2 days apart. Comparisons of the results showed that the times of day of greatest sensitivity to x irradiation coincided with the maxima of nuclear size in various tissues. It was concluded that the circadian rhythms observed were related to daily rhythmic changes in the nucleoproteins of the nucleus or the nuclear membrane system. These changes would have affected survival in a very complex way. (BBB)

Vertebrates

Refer also to abstracts 43655, 43662, 43674, 43679, 43680, 43692–43697, 43702, 43706, 43708, 43710–43714, 43725, 43741, 43745, 43786, 43799–43806, 43848, and 43893.

43855 (CONF-681216-1) EFFECTS OF CHRONIC EXPOSURE OF CHINOOK SALMON EGGS AND ALEVINS TO GAMMA IRRADIATION. Donaldson, Lauren R.; Bonham, Kelshaw (Washington Univ., Seattle. Coll. of Fisheries). [1966]. Contract AT-(45-1)-2056. 24p. Dep. CFSTI.

From 135th Meeting of the American Association for the Advancement of Science, Dallas, Tex.

Chinook salmon eggs and alevins were exposed continuously to low levels of gamma radiation from a ^{60}Co source, from the instant of fertilization until the yolk sac was completely absorbed. The irradiated fish were compared with a similar stock that was not exposed to irradiation. The level of irradiation exposure was gradually increased from 0.5 roentgen/day for the 1960 brood year, to 1.3 roentgens/day in 1965, 2.8 roentgens/day in 1966, 5.0 roentgens/day in 1967 and to 10.0 roentgens/day, a total of 820 roentgens, for the 1968 brood year. At levels of 0.5 roentgen/day no damaging effects were found. The data for the higher levels of exposure will be evaluated as the adults return from the sea. Studies are carried on during the entire life span of the fish. (auth)

43856 (UCD-472-242) QUARTERLY PROGRESS REPORT [ON EFFECT OF RADIATION ON BEAGLES], JUNE 30, 1969. (California Univ., Davis. Radiobiology Lab.). 1p. Dep. CFSTI.

Radiosterilization of Beagle ovaries was demonstrated following exposures in 10R fractionations. Studies are currently underway using 2.5R to 10R fractionated exposures totalling doses of 50 to 200R to define the most radiosensitive period and minimum doses required for sterilization. In other Beagle studies, a thrombocytopenia was found in one of the dogs in the single-injection ^{90}Sr studies; erythrocytic blood typing factors are being determined; an age-related marked increase in lipofuscin accumulation in Beagle brains was determined; and the influence of radiation on this increase is currently being studied. In vitro studies on uptake of labeled deoxyribonulceosides by transformed lymphocytes and fresh bone marrow cells indicate a consistent difference in the ratio of base utilization between lymphocytes and bone marrow cells in Beagles. In a collaborative study on the structure of chromosome gaps, using Marmosa mitis cells, a technique was derived to permit photography of chromosomes and chromosome-like objects. (E.R.B.)

43857 IN VITRO CONTRACTIONS OF RAT JEJUNUM FOLLOWING WHOLE-BODY X IRRADIATION OR DRUGS. Kagnoff, M. F.; Kivy-Rosenberg, E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Amer. J. Physiol., 216: 1057-63(May 1969).

Adult male rats were sacrificed between 20 min and three days following 1,500 R whole-body x irradiation to record and study the spontaneous contractions of isolated in vitro segments of jejunum. Segments from nonirradiated animals demonstrated a multicomponent irregular pattern of contractions as compared with a single-component regular pattern, often associated with an increased contraction amplitude, in segments taken from animals two and three days after exposure. No increase in the mean rate of spontaneous contractions was noted. The mechanism of this change was studied using pharmacological agents. The ganglionic blocking agent hexamethonium, the anticholinesterase drugs, as well as the neurotoxin tetrodotoxin, when added to the bath containing segments from nonirradiated animals, resulted in a contraction pattern resembling that of segments from animals irradiated two and three days previously. Evidence is presented, however, which indicates that

drug-altered segments differ in some aspects from the radiation-induced regular segments. The possible mechanisms of the irradiation-induced changes are discussed. (auth)

43858 COMBINATION THERAPY WITH RADIATION AND MITHRAMYCIN OR ACTINOMYCIN D IN A TRANSPLANTED MOUSE GLIOMA. McNulty, Thomas B.; Dirks, Victor A.; Yarbro, John W.; Kennedy, B. J. (Univ. of Minnesota, Minneapolis, Coll. of Veterinary Medicine, Minneapolis). Cancer, 23: 1273-9(June 1969).

Mouse glioma tumors implanted in C57 black mice were treated with mithramycin or actinomycin D, radiation therapy, and each of these chemical agents in combination with radiation therapy. Response of the tumors to treatment was measured in terms of tumor size, linear growth rate, and survival. Both mithramycin and actinomycin D reduced linear growth rate, but survival was not different from the control animals. The antitumor effects of a single course of the chemotherapeutic agents given alone were of relatively short duration. Radiation therapy reduced tumor size, the linear growth rate was less than with the chemotherapies, and survival was prolonged. Actinomycin D or large doses of mithramycin combined with radiation therapy produced a greater reduction of tumor size and linear growth rate than did any of the therapeutic agents alone. Combination therapy was associated with a phenomenon of increased mortality in the early phase of the experiment. There is a suggested enhancement of antitumor activity when these chemotherapeutic agents and radiation therapy are employed in combination. (auth)

43859 RADIATION INHIBITION OF POST-TRAUMATIC REGENERATION OF THE NERVE. Zhutaev, I A. (Inst. of Medical Radiology, Erevan). Med. Radiol., 14: No. 8, 35-40(Aug. 1969). (In Russian).

The author conducted local x-ray irradiation of a region of the sciatic nerve in Wistar rats in a dose of 3,000 R per day prior to its section and three days after the latter. It is shown that irradiation of the nerve prior to section causes an inhibited growth of regenerating axons and deceleration of their differentiation. The radiation effect after the operation mainly leads to retardation of myelinization and does not delay essentially the growth of young axons. Autoradiography with methionine ^{35}S revealed that irradiation of the nerve one day before the operation exerts an inhibiting effect on the protein synthesis by tissues of regenerating nerve. (auth)

43860 BIOLOGICAL EFFECT OF TRITIUM OXIDE IN PROLONGED INTRODUCTION INTO THE ORGANISM. Lyaginskaya, A. M.; Zhukova, I. V.; Veselovskaya, K. A.; Istomina, A. G. Med. Radiol., 14: No. 8, 61-6(Aug. 1969). (In Russian).

When tritium oxide was administered to rats for a period of 30 to 160 days in doses of 16 and 60 μCi a chronic form of radiation sickness developed. The severity of affection depended directly on the total activity introduced. Changes were most pronounced at the end of the administration of the isotope. After cessation of isotope administration there was no restoration of functioning of the cardiovascular, respiratory, or reproductive systems. The peripheral blood indices were normal in all groups of animals. (auth)

43861 EFFECT OF PARTIAL MARROW SHIELDING ON HEMATOPOIETIC RECOVERY IN HEAVILY IRRADIATED MICE. Ito, Takaaki; Ito, Akihiro; Imamura, Nobutaka; Kawase, Akira; Yamasaki, Takao; Nishihara, Homi; Yokoro, Kenjiro (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 61-74(1969). (In Japanese).

The hemato-pathological, autoradiographic and assay for the spleen colony formation were applied to heavily x-irradiated mice in which either the shielded limb was amputated at various intervals after x-irradiation or the various doses of sublethal x-irradiation were given to a shielded limb. The obtained results are as follows. The hematopoietic recovery was markedly promoted by the shielding of one hind limb. This effect seemed to be attributable most likely to the repopulation of hematopoietic cells in irradiated sites, which is generated by the hematopoietic stem cells (HSC) migrated from the shielded marrow. The migration of HSC from the shielded marrow seems to start quite early after the completion of x-irradiation. A sufficient number of HSC migrated within one hour, which brings a substantial promotion of the hematopoietic recovery in the irradiated sites. The number of HSC in the shielded marrow showed no significant decrease during the first 5 hours after x-irradiation though certain numbers of HSC appeared to migrate to the irradiated sites during this period. It is conceivable that a homeostatic mechanism operated rapidly to maintain the size of HSC pool in substituting the migrated HSC. The migrating HSC appeared to possess the affinity to certain specific sites according to their potential cell type: erythroid cells to the spleen and granuloid cells to the bone marrow. Megakaryocytes were distributed in an approximately equal number in both spleen and marrow. Although the accurate radiosensitivity of HSC has not been evaluated, a decrease of migrating ability or mitotic inhibition of HSC would be brought about even by a relatively small dose (200 R), leading to the retardation of the hematopoietic recovery of the irradiated sites as compared to mice, a part of whose hematopoietic sites has been completely shielded during irradiation. The partial shielding of hematopoietic sites gave also a beneficial effect to the recovery of the lymphoid tissues. In this process, the regeneration of the peripheral lymphoid tissues such as white pulp of the spleen or lymph nodes was preceded by that of thymus. (auth)

43862 LATE SOMATIC EFFECTS OF DIVERSE RADIATIONS (FAST NEUTRONS, GAMMA-RAYS, AND ^{32}P) IN W/Fu RATS WITH SPECIAL REFERENCE TO THEIR TUMORIGENICITY. Takizawa, Shoichi; Yamasaki, Takao; Nishihara, Homi; Nishihara, Eimi; Kawase, Akira; Yokoro, Kenjiro (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 48-60(1969).

Long term effects of diverse radiations such as 288 rads of fast neutrons, 442 rads (460R) of gamma-rays and 5 c/g of radioactive phosphorus (^{32}P) were studied in the inbred young rats of Wistar/Furth strain. Sixty three to seventy seven % of the externally irradiated rats lived for more than 500 days following the irradiation, while in the ^{32}P-injected rats only 17% of females survived the same period. The marked shortening of the longevity in the ^{32}P group might be attributable to the intense damages by this type of radiation on the dental and hematopoietic tissues. In the gamma-ray group as well as in the fast neutron group, approximately 90% of females and 35 to 55% of males had tumors 700 days after irradiation. No significant differences were observed between gamma-rays and fast neutrons at the given doses in the rate and the diversity of the tumor development. On the other hand, in the ^{32}P-injected rats only a quarter of females and approximately 17% of males developed tumors. Mammary tumors, which constituted the largest group in the radiation-induced neoplasms, accounted for nearly 40% of all tumors and were found in 72% of female rats. The majority of mammary tumors were of fibroadenoma type and the remainders were of adenocarcinoma type. A high incidence of mammo-somatotropic pituitary tumors, especially in the female was observed in both gamma-ray and fast neutron irradiated rats. The multiplicity of tumor development was not frequently seen among the pituitary tumor bearing rats. Three cases of renal adenocarcinomas and one case of renal adenomas were observed among 54 of the externally irradiated rats. The exceptional occurrence of ovarian tumors and leukemia in W/Fu rats was consistent with other reports and was in sharp contrast to the results in irradiated mice. (auth)

43863 EFFECTS OF X-IRRADIATION ON GASTRIC REGION OF MICE WITH RESPECT TO INDUCTION OF GASTRIC ADENOCARCINOMA. Hirose, Fumio (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 32-47(1969). (In Japanese).

The gastric region of twenty-one 82 to 88-day-old CF_1 female mice in Group I was irradiated with 1,500 rads of x-ray at one-week interval for a total of six exposures (total radiation dose of 9,000 rads) and of twenty-four 59-day-old CF_1 mice of both sexes in Group II was irradiated with 2,000 rads of x-ray at one-week interval for a total of five exposures (total radiation dose of 10,000 rads). In Group I, 17 mice survived for more than 16 weeks after the initial irradiation, and mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 88%, atypical hyperplasia (precancer) in 35%, and gastric adenocarcinoma in 12%. In Group II, 18 mice survived for more than 14 weeks after the initial irradiation, and mucosal atrophy of the glandular stomach was seen in 100% of the mice, ulceration in 78%, atypical hyperplasia (precancer) in 44%, gastric adenocarcinoma in 28%, and squamous cell carcinoma in 6%. A total of seven cases of gastric adenocarcinoma was observed of which two had metastasis to the pancreas or mesentery. (auth)

43864 EFFECTS OF X-IRRADIATION OF A PART OF THE BODY ON MORTALITY RATE AND ON HISTOLOGICAL CHANGES IN THE GOLDFISH, CARASSIUS AURATUS. Etoh, Hisami; Hyodo-Taguchi, Yasuko; Maruyama, Takashi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res., 9: 141-51 (Sept.-Dec. 1968).

The effect of partial-body x-irradiation on the goldfish, Carassius auratus, was studied. After anesthetization with MS 222, regions of the head, abdomen or tail of goldfish were exposed to 1 to 16 kR of x-rays from the lateral side. Fish receiving whole-body irradiation served as controls. Exposures were measured with Radacon and doses absorbed in the body were estimated using fluoro-glass dosimeters inserted in each of three parts of the body whether exposed to, or shielded from, x rays. Doses absorbed in

directly exposed regions (e.g., the abdomen) were around 330 rads and those in the shielded regions (e.g., both the head and the tail) were about 17 rads. Thirty day-mortality rates increased with increasing integral dose. The commencement of radiation death at about 10 days after partial-body irradiation corresponded with observed histological damage in the intestine and death at around 20 days with damage in the hematopoietic tissues (the head and body kidneys). Skin death owing to irradiation occurred considerably later. From these results it is apparent that mortality rate following partial-body irradiation depends not only on exposure and damage of the directly irradiated part, but also on the dose absorbed in the tissue as a whole. (auth)

43865 THE EFFECTS OF MICRO-ORGANISMS ON RADIATION PATHOLOGY, AND BONE MARROW THERAPY IN WHOLE-BODY IRRADIATION. Wilson, Raphael (Univ. of Notre Dame, Ind.). J. Amer. Osteopath. Ass., 67: 653-62(Feb. 1968).

The radiation studies described utilized germfree animals to assess the effect of micro-organisms on the response of mammals to whole-body ionizing irradiation, on the recovery phenomena, bone marrow therapy, and the action of protective agents. This report also reviews the results of radiation studies in germfree mice carried out to determine the role of micro-organisms in survival time, hematologic changes, hypoferremia, intestinal effects, treatment with bone marrow, and survival in secondary disease. In the initial study germfree and conventional mice of the Lobound-maintained Swiss-Webster strain were exposed to single doses of x radiation, from 500 to 3000 R. The LD_0 to LD_{100} range for conventional mice was 550 to 750 R, and for germfree mice was 600 to 850 R. The LD_{50} x-ray dose was 660 R for conventional mice and 705 for germfree mice. Survival time dropped sharply from about 8 to 4 days as the dose increased between 1000 and 1250 R and leveled off at 1750 R to a survival time of about 3 days. At doses below 1000 R, germfree mice that succumbed to irradiation lived about 4 days longer than their conventional counterparts. At doses above 1000 R the difference in survival was most pronounced between 1000 and 2000 R. At 3000 R, germfree mice lived twice as long as conventional mice exposed to the same dose. Germfree mice had total leukocyte, lymphocyte, reticulocyte, platelet, and hematocrit values about 10% lower than those of conventional mice. Hematologic changes after various doses are described in detail. At the 2 higher doses there was a lesser degree and slower development of anemia in the germfree mice and a slower reduction in the number of platelets. Hemorrhage occurs to a lesser degree and at a later time in germfree mice, a possible explanation for this difference. A closely comparable sensitivity of lymphocytes to ionizing radiation in germfree and conventional mice was found. Germfree and conventional mice under control conditions presented an identical serum-bound iron (SBI) pattern. Different SBI response patterns were evoked after exposure to 850-R whole-body x irradiation. The hyperferremia in x-irradiated germfree mice was in sharp contrast to the induced hypoferremia of x-irradiated conventional animals. Evidence that the serum iron decrease after irradiation was due directly to a loss of specific iron-binding β_1-globulin transferrin was presented, in which a 50% loss of protein was shown to occur in conventional mice 5 days after 850 R irradiation. The gross decrease in total serum protein and albumin levels that accompanied administration of endotoxin indicated that the alteration in the vascular permeability was accompanied by a leakage of serum protein. The results indicated that bacteria and other agents contribute to the postirradiation pathologic state by altering the normal anatomic and physiologic status of the host directly and through the pharmacologic action of products of microbial origin. (BBB)

43866 EXTRACORPOREAL IRRADIATION OF THE CIRCULATING BLOOD: WAYS OF STUDYING THE CIRCULATION AND RECIRCULATION OF LYMPHOCYTES IN THE CALF. Cottier, H. (Univ., Bern); Ruchti, C.; Sordat, B.; Cronkite, E. P. Nouv. Rev. Franc. Hematol., 8: 679-84(Sept.-Oct. 1968). (In French).

Methods for studying lymphocyte dynamics in the calf by extracorporeal circulation are described. In 48 animals, heparinized blood was pumped via a venous shunt through a coil exposed to x radiation. The flow time through the coil was 3 min at a flow rate of 300 ml/min with an x-ray exposure of 300 rad. It was calculated that the total blood volume was irradiated in 5 hr. Lymphocyte counts were determined in blood, lymph, spleen, and various lymph nodes up to 48 hr after irradiation. The results showed that circulating blood lymphocytes are eliminated by prolonged and/or repeated extracorporeal irradiation of the blood. While blood and thoracic duct lymphocyte counts were rapidly depressed by this procedure, the lymphocyte content of cortical zone in lymph nodes remained near normal, and lymphocyte depletion in certain areas of the spleen were only moderate. These findings are discussed in relation to the problems of lymphocyte recirculation, readily mobilizable pools of lymphocytes, and immune reactions. (BBB)

43867 TECHNICAL PROBLEMS POSED BY EXPERIMENTAL USE OF IRRADIATION IN EXTRACORPOREAL CIRCULATION. Hollard, D.; Suscillon, M.; Barnique, J.; (and others) (CEN, Grenoble, France). Nouv. Rec. Franc. Hematol., 8: 673-8(Sept.-Oct. 1968). (In French).

Problems encountered in extracorporeal irradiation (ECI) of the blood in calves are described. Normal hematologic parameters in calves were extensively studied. ECI was carried out with a carotid-jugular shunt without auxiliary pumping of the blood. A 1500-Ci ^{60}Co source was used to provide irradiation in the shunt circuit. In the use of ECI as a method of peripheral cellular destruction, several technical problems arose and are explained. The effect of irradiation on the morphology and the function of the cells passing through the extracorporeal shunt was examined. One advantage of the ECI method is that it permits irradiation of the cells in their ambiant plasma medium, which is not possible in in vivo irradiation of other types. Initial results of ECI are presented, with particular attention to platelet function and hemostasis, in regard to the following points: problems with tubes and joints; problems posed by not using heparin; results of dosimetry. (BBB)

43868 FURTHER STUDIES ON SERUM PROTEIN FORMATION BY CHIMERAS. II. INDUCTION OF CHIMERISM WITH SUBLETHAL X-IRRADIATION AND HETEROLOGOUS ANTI-ORGAN SERUM. Kikuchi, Yuko; Phillips, Mildred E. (New York Univ., N. Y.). Proc. Soc. Exp. Biol. Med., 131: 841-5 (July 1969).

Mice were x irradiated and given injections of rat bone marrow within 4 hr. Antiserum against lymphocytes (ALS) or thymocytes (ATS) were given twice weekly for 7 wk. Blood samples and cultured mesenteric lymph nodes and spleen tissues were examined by radioimmunoelectrophoresis. Autoradiographs of the immunoelectrophoretic patterns developed with rat serum as a carrier and culture fluids obtained from spleens removed 3 weeks (ALS group) and 4 weeks (ATS group) after bone marrow transfer showed a stronger intensity of labeling of IgG_2 with culture fluids obtained from the ATS-treated animals than that from ALS-treated animals. Successful induction of chimerism and increased survival were obtained by treatment with small doses of ALS and ATS, previously absorbed with mouse red blood cells, combined with sublethal x irradiation. The results are attributed to the marked reduction in the side effects on the host (from lethal x irradiation or large doses of ALS) that were incompatible with survival and also to the establishment of adequate central and peripheral immune suppression afforded by a fortuitous combination of these two treatments, permitting xenogeneic graft survival. (C.O.)

43869 INHIBITION OF GRANULOMA FORMATION AROUND SCHISTOSOMA MANSONI EGGS. IV. X-IRRADIATION. Perrotto, Joseph L.; Warren, Kenneth S. (Case Western Reserve Univ., Cleveland). Amer. J. Pathol., 56: 279-91(Aug. 1969).

Mice given intravenous injections of schistosome eggs have a reproducible granulomatous reaction in the lungs that peaks at 16 days. Treatment with repeated 7 R and 30 R whole-body x irradiation for 8 weeks prior to egg injection resulted in moderate to marked lymphopenia and suppressed circulating antibody, but had no appreciable effect on granuloma formation. Single-dose 450 R x irradiation, which resulted in lymphopenia and inhibited circulating antibody, did suppress granuloma formation for a period of about 3 weeks after egg injection. Mice sensitized with an intraperitoneal dose of eggs 1 week prior to egg challenge and exposed to repeated 30 R x irradiation showed a marked lymphopenia, but no change in granuloma size at the peak granuloma response time of 8 days. Also, mice treated with repeated 30 R x irradiation and given intravenous injections of plastic beads demonstrated a marked peripheral lymphopenia without any change in the peak foreign body granulomatous response at 2 days. These findings indicate that the schistosome-granuloma is relatively radioresistant, and that its behavior is similar to that of other cellular hypersensitivity phenomena. In addition, because granuloma formation was unimpaired in spite of the suppression of circulating antibody and the occurrence of marked lymphopenia, it is concluded that neither of these factors in and of itself plays a major role in the granulomatous reaction to schistosome eggs. (auth)

43870 CHARACTERISTICS OF THE LETHAL EFFECT OF X AND γ RADIATION ON MOUSE TYPE B SPERMATOGONIA. Bianchi, Marilena; Quintiliani, Marcello. Ann. Inst. Super. Sanita, 5: 39-47(1969). (In Italian).

The survival of type B spermatogonia in testes of mice irradiated with 220 kV x rays and with ^{60}Co γ rays was calculated. The shape of the calculated survival curve for x irradiation at the dose-rate of 2.9 rad/min is sigmoid with a D_q of 20.2 rad and an extrapolation number of 1.3. The survival of type B spermatogonia after γ irradiation at 4.7 rad/min, 0.3 rad/min, and 0.1 rad/min was found to be superimposable, within the limits of experimental error, to that observed after equal doses of x rays. (auth)

43871 A DIRECT METHOD FOR PREPARING METAPHASE PLATES FROM THE 8-DAY RAT EMBRYOS. Shimada, Katsunobu; Yamada, Shigeyuki; Satow, Yukio; Ikeda, Takayoshi; Okamoto, Naomasa (Hiroshima Univ.). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 113-18(1969). (In Japanese).

Anomalies of the heart and various organs of rat fetuses were induced in a high frequency (approximately 95%) by irradiating female rats with 14.1 MeV fast neutrons eight days after conception. In an effort to elucidate the developmental mechanism of such anomalies, analyses were carried out from the morphological, biochemical, and cytogenetic points of view. In order to observe effects of radiation on the rat embryo, chromosome studies were made. A new procedure for studying the chromosomes is described. Colchicine was injected intraperitoneally into pregnant females one hour before they were sacrificed. Eight day old embryos were removed, suspended in a trypsin solution, and centrifuged at 800 rpm for 5 min. Cells were fixed in methanol-acetic acid solution and stained with Giemsa's solution. This method for demonstrating chromosome changes in experimental teratology is more effective than the tissue culture method. (H.L.W.)

43872 ROLE OF ENDOTOXINS IN THE PATHOGENESIS OF HEMORRHAGIC SYNDROME IN ACUTE RADIATION SICKNESS. Volodin, V. M.; Oivin, V. I.; Tokarev, O. Yu.; Gumenyuk, L. I. (Inst. of Medical Radiology, Erevan). Med. Radiol., 14: No. 8, 29-35(Aug. 1969). (In Russian).

The role of endotoxins of Gram-negative bacteria in the pathogenesis of hemorrhagic syndrome in acute radiation sickness was studied. Experiments conducted on irradiated rabbits both in conditions conducive to and preventing intravascular blood clotting under the influence of endogenous. Gram-negative endotoxins demonstrated that the development of hemorrhagic diathesis in acute radiation sickness is not associated with the action of endotoxin on the blood and subsequent occurrence of thromborrhagia according to mechanisms of generalized phenomenon of Sanarelli-Swartzman. Protracted administration to nonirradiated guinea pigs of E. coli 0127:B_8 endotoxin (lipopolysaccharide, Difko) and endotoxin isolated from E. coli, notwithstanding intoxication also demonstrated the inability of endotoxins of Gram-negative bacteria to cause hemorrhagic syndrome similar to that of radiation. (auth)

43873 LIGHT TRANSMISSION BY CORNEAS, AQUEOUS HUMOR, AND CRYSTALLINE LENSES OF FISHES. McCandless, Richard L.; Hoffert, J. Russell; Fromm, Paul O. (Michigan State Univ., East Lansing). Vision Res., 9: 223-32(Feb. 1969).

The effect of uv light of various wavelength on corneal and lens lesions was considered in a study of the transmission of different wavelengths of light by components of fish eyes. Excessive uv irradiation may be a cause of various types of cataract. Corneal and lenticular lesions (keratoconus, ulcerative keratitis, and cataracts) may develop during the second year of life in hatchery-reared lake trout and more rarely in rainbow trout, but fail to develop when the hatchery raceways are shielded from direct sunlight. When free in nature, lake trout normally are found at a water depth of about 100 ft or more but rainbow trout normally inhabit much shallower waters. The possibility that uv radiation in sunlight might be involved in the genesis of ocular lesions led to a comparison of the light transmission properties of corneas, lenses, and aqueous humor of these 2 species. Corneas of lake trout and rainbow trout absorbed the same amount of light of 350 mμ wavelength. Below this wavelength lake trout corneas absorbed more light than rainbow trout corneas, whereas, at 400 mμ and above they absorb an average of 20% less. Lenses from lake trout absorbed more light of shorter wavelengths than those from rainbow trout. It is speculated that uv light absorbed by mucopolysaccharides or by aromatic amino acids of proteins (wavelengths about 260 mμ) might initiate damaging changes in any of the exposed eye tissues. Also, near-uv (about 350 mμ) or visible radiation might be absorbed by pigment molecules associated either with cellular enzyme systems or with particular cellular sites (photodynamic damage), and reactions linked to this pigment absorption might lead to cellular damage. Since sunlight contains little light of wavelengths less than 300 mμ, damage by uv light to nucleic acids (at 260 mμ) or proteins (at 280 mμ) may be unlikely. Increasing the depth of raceway water by as little as 12 in. was found to result in a significant decrease in the incidence of eye lesions in lake trout. (BBB)

43874 SOME HEMATOLOGICAL CHANGES IN RATS IRRADIATED BY LOW DOSE RATES OF CONTINUOUS IRRADIATION. Chlebovsky, O.; Praslicka, M. pp 219-20 of Some Problems of Aviation and Space Medicine. Levit, Pavel (ed.). Prague, Charles University, 1967.

The effects of continuous exposure to low doses (0.26 R and 1.8 R/day) of ^{60}Co γ radiation on the hematopoietic system in rats were studied. These low doses caused an increase in the number of nongranular leukocytes in peripheral blood during the first two months of exposure, followed by a decrease to approximately 40% of normal values. No significant changes were found in the number of granular leukocytes or erythrocytes. The incidence of chromosome aberrations in bone marrow cells was increased within 30 days following initial exposure, when a steady state was reached. (C.H.)

43875 THE ACTION OF VERY LOW γ-RAY DOSES ON FROG LIVER TISSUE RESPIRATION DUPING SPRING RECOVERY. Pora, E. A.; Manciulea, St.; Suteu-Rusdea, A. Rev. Roum. Biol., Ser. Zool., 13: 193-5(1968). (In French).

The action of the two radiation thresholds upon some physiological processes was studied. It was found that slight radiation doses have a stimulating effect, called radiobiological homeopathy, whereas high doses have an inhibiting effect in Rana esculenta. The homeopathic effect on respiration was followed with very low γ-ray doses delivered daily to tissues of frog liver during spring, when an intense metabolic activity takes place following water dormancy. Tissue respiration was measured by the Warburg method at 22°C for an hour, using a Ringer solution. A higher hepatic tissue respiration was noticed during the whole test period in animals exposed two hours a day to 114 mR from a ^{60}Co source than in control animals. The stimulating action of very low γ-ray doses is due to the occurrence of new non-toxic substances which stimulate tissue respiration. (Rom. Sci. Abstr.)

43876 THE CHICKEN COMB AND WATTLE AS EXPERIMENTAL MODEL FOR INVESTIGATIVE ARGON LASER THERAPY OF ANGIOMAS. Ritter, Edmond J.; Goldman, Leon; Richfield, Daniel; Rockwell, R. James Jr.; Franzen, Marilyn (Univ. of Cincinnati). Acta Dermato-Venereol., 49: 304-8(1969).

In the course of treatment of 89 patients with various types of portwine lesions by laser irradiation, an animal model was developed suitable for determining the effects of laser variables on vascular tissues. This is the chicken comb, wattle and ear lobe, which exhibit a high degree of capillary proliferation, and bear histological resemblance to the human portwine lesion and senile angioma. The argon laser beam caused a sharp zone of epidermal coagulation from the underlying dermis producing a shallow cleft. The dermis showed a well-defined zone of injury characterized by vascular wall compression, endothelial cell and collagen tissue coagulation. Later, the epidermis as well as the dermis was thinned significantly. There was loss of dermal mucin and beginning fibrosis. The vessels of the superficial network were markedly diminished in number (90 to 95% decreased) and the deeper dermal zone of vascular engorgement had disappeared. At 30 days postirradiation, the zone of injury showed atrophic epidermis, extensive fibrosis, and beginning superficial revascularization due to the growth of capillary buds into the injured zone from superficial dermal vessels lateral to the site of the injury. No significant difference was found with the range of dose studied, nor with the different wavelengths used. (BBB)

43877 HIGH CONTENTS OF VITAMIN B_{12} IN BLOOD. 3. HIGH VITAMIN B_{12} CONTENTS OF BLOOD AND INCREASED URINARY EXCRETION OF VITAMIN B_{12} IN RATS FOLLOWING WHOLE-BODY IRRADIATION. Oomae, Kiyokazu (Hiroshima Univ.). Bitamin, 39: 129-36(Feb. 1969). (In Japanese).

In order to elucidate the mechanism of the high blood contents of vitamin B_{12} and increased urinary excretion of B_{12} in human leukemia, the study of B_{12} metabolism in rats following whole-body ^{60}Co γ irradiation was undertaken. It is a well-known fact that peripheral leukocytes show a considerable decrease within 3 days following LD_{50} irradiation, but when B_{12} metabolism was examined in the rat during the same period, it was found that the B_{12} level in blood showed a temporary significant increase during the 3 to 24 hour period following irradiation. Urinary excretion of B_{12} in the rat, even in controls, is more than 30 times that in the human body (the weight of the rat being converted to that of the human body), but when the rat was irradiated, a significant increase in urinary excretion of B_{12} was found within 48 hours. It was postulated that the increase in B_{12} level in blood within 24 hours, and increase in excretion of B_{12} within 48 hours after irradiation are attributed to B_{12} release from leukocyte destruction. (NSA of Japan)

43878 METHOD OF IRRADIATION OF BIOLOGICAL OBJECTS IN A UNIQUE STATIONARY STRONG γ INSTALLATION. Nurmukhamedov, B. (Tashkent State Medical Inst.). Dokl. Akad. Nauk Uzb. SSR, No. 9, 44(1968). (In Russian).

Experiments carried out with a unique cobalt installation capable of recording rabbits' exposure time in a (20 r/sec) ^{60}Co source with the precision up to 0.1 sec are described. The rabbits that were irradiated for 20 sec with 400 R and for 40 sec with 800 R

exhibited second and third degree radiation sickness, respectively. (R.V.J.)

43879 STUDIES ON LYMPHOCYTES. XIV. MEASUREMENT OF DNA SYNTHESIS TIME ON BOVINE THORACIC DUCT LYMPHOCYTES BY ANALYSIS OF LABELED MITOSES AND BY DOUBLE LABELING, BEFORE AND AFTER EXTRACORPOREAL IRRADIATION OF THE LYMPH. Vincent, P. C.; Borner, G.; Chanana, A. D.; Cronkite, E. P.; Greenberg, M. L.; Joel, D. D.; Schiffer, L. M.; Stryckmans, P. A. (Brookhaven National Lab., Upton, N. Y.). Cell Tissue Kinet., 2: 235-47(July 1969).

Some of the time parameters of the cell cycle in bovine thoracic duct lymphocytes were estimated by analyzing labeled mitoses curves, and by double labeling. The two methods gave similar estimates of T_s. Thus, T_s measured directly from labeled mitoses curves varied from 4 to 6 hr, while the estimates from double labeling were 4.8 and 4.5 hr. T_G measured directly from labeled mitoses curves was 5 hr, and estimates of T_G from the values of T_s ranged from 6.3 to 7.7 hr. The present data confirm the short generative cycle of large thoracic duct lymphocytes. Extracorporeal irradiation of the lymph (ECIL) had no detectable effect on the cell cycle or the fractional production rate of the lymphocytes. However, the calculated absolute production was reduced following ECIL, due to a decrease in the absolute number of cells present. The grain count over mitoses after ECIL was approximately one-half that found before ECIL. (auth)

43880 EFFECT OF PRIOR RESECTION OR LACTATION ON SURVIVAL TIME OF INTESTINE-IRRADIATED RATS. Sigdestad, Curtis Paul. Iowa City, Iowa, Univ. of Iowa, 1968. 98p.

Thesis.

The effect of resecting 70% of the combined ileum and jejunum on the survival time of rats subjected to x irradiation of only the remaining ileum and jejunum was studied. The variables tested were time of irradiation after the surgical procedure (7, 15, 30, and 60 days) and the exposure to the exteriorized gut (1500, 2000, 2500, 3000, and 3500 R). Using cumulative mortality and time to death as endpoints, it was shown that the resected group withstood the irradiation treatment better than did the sham resected group. The protective effect was enhanced with an increased time between surgical and irradiation treatments and was decreased with increased x-ray exposure. The results seem to show in the resected gut the same effect described in the bone marrow by Jacobson et al., i.e., induced hyperplasia protects against ionizing radiation. Because the duodenum was not irradiated and its compensatory changes may be significantly related to the protective effect, its role should be considered. The influence of the duodenum may be tested by including it in the irradiation field. Any substantial change in survival time may support the contention that the duodenum is partially responsible for the protective effect. The survival time of rats irradiated abdomen-only thirty days after a 70% resection of the combined ileum and jejunum was studied. The abdomen from the xiphoid process to the pubic symphysis (which includes the duodenum) was exposed to either 1000, 1500, or 3000 R of 250 kVp x rays. There was a complete abolishment of the protective effect. It was tentatively concluded that the inclusion of other organs in the course of abdominal irradiation altered the response to such a degree that any protective effect that possibly resided in the duodenum was masked. The protective effect of a 70% resection prior to intestine-only irradiation was tentatively proposed to be due to induced hyperplasia. To test this hypothesis, hyperplasia was induced by other means (i.e., lactation) and the survival time after intestine-only x irradiation was studied. Male, virgin female, primiparous, and lactating rats were used. Sixteen days post partum, the primiparous and lactating animals along with appropriate control groups were irradiated with 1500, 2500, or 3000 R to the exteriorized small intestine from the ligament of Treitz to the cecum. The survival time was followed. The survival time of the lactating groups was not significantly longer than the male, virgin female, or recently parous but non-lactating controls. The mechanism of enhanced survival time when a 70% resection of the small intestine was performed prior to x irradiation is obscure. (Diss. Abstr.)

43881 CONTRIBUTION TO THE PROBLEMS OF DIAGNOSIS OF CHRONIC POSTRADIATION DAMAGE. Beran, M.; Pospisil, J.; Havlicek, F.; Dvorak, P. (Vyzkumny Veterinarni Ustav, Prague). Cas. Lek. Cesk., 107: 1123-8(1968). (In Czech).

In a group of rats chronically irradiated for a period of 400 days with a dose of 3654 mR, in the course of 24 hours throughout the experimental period weight increments and the peripheral haemogram were investigated (total number of leukocytes, lymphocytes, neutrophil granulocytes, erythrocytes, reticulocytes, thrombocytes, hematocrit values, hemoglobin). The only typical change observed was permanent mild lymphopenia. The other values varied either irregularly or did not change throughout the period of observation. The reliability of hematological criteria for the evaluation of damage caused by chronic small doses of ionizing irradiation is discussed. (tr-auth)

43882 EFFECT OF WHOLE-BODY X RADIATION ON THE CELL COUNT OF BONE MARROW. Zak, Miroslav; Husakova, Brigitta (Karls-Univ., Prague). Strahlentherapie, 138: 115-19(July 1969). (In German).

The modifications of the number of cells in the bone marrow of mice were followed after whole-body irradiation depending on the dose (100, 600, or 1000 R) and on the time elapsed after irradiation (1, 5, 14, and 28 days). After 100 R, non-significant variation of the cell number was observed during 28 days. A dose of 600 R resulted in a cyclic variation of the cellularity with maximal depression at the fifth day. Within the observation period, the number did not become normal. A dose of 1000 R provoked a progressive decrease of the cell number. (auth)

43883 ANIMAL STUDIES OF ELECTROCARDIOGRAPHIC CHANGES AFTER HIGH DOSES OF RADIATION TO THE HEART REGION. Wende, Wolfram; Braun, Heribert; Kluetsch, Karl; Bohndorf, Werner (Univ., Wuerzburg, Ger.). Strahlentherapie, 138: 101-4(July 1969). (In German).

Urethan anesthesized rats received telecobalt irradiation to the heart region with doses up to 160,000 R. After 40,000 R the ECG revealed a shortening of the relative PR-duration, while after 80,000 R a progressive badycardia with an increasing prolongation of the relative PR-, QRS-, and QT-duration. These were associated with bundle branch blocks, a.v.-conduction disturbances, and an increase of the T-wave-amplitude. At this time serum-potassium had increased to 7.1 mEq/1. The ECG-alterations were interpreted as a result of x-radio-induced disturbances of the transmembrane ionic transport mechanism. (auth)

43884 REGENERATING BONE-MARROW CELL LINES IN TWO DIFFERENT X-IRRADIATION CONDITIONS. Delrez, M.; Haot, J.; Betz, E. H. (Univ., Liege). Int. J. Radiat. Biol., 15: 405-9(1969).

Two different conditions of bone-marrow recovery were compared in irradiated mice where the cell repopulation occurs after similar delays. A sub-lethal irradiation produces an accumulation of medullary lymphoid elements (transitional cells; X cells). On the contrary, a lethal irradiation followed by the injection of 5×10^6 normal bone-marrow cells fails to induce any lymphoid rebound. No difference can be shown for the other cell lines (myeloid and erythroid series). The possible role of the X cells is discussed in the light of these observations. (auth)

43885 THE RBE OF 14 MeV NEUTRONS. OBSERVATIONS ON COLONY-FORMING UNITS IN MOUSE BONE-MARROW. Duncan, W.; Greene, D.; Howard, A.; Massey, J. B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 15: 397-403(1969).

The effectiveness of 14 MeV neutrons from the D-T reaction was compared with that of ^{60}Co γ-radiation in killing mouse bone-marrow cells capable of forming spleen colonies after transfer to lethally irradiated isologous recipients. The survival curves for the two radiations were found to have the same extrapolation number (1.38 ± 0.15). The D_0 for neutrons was 63.7 ± 3.3 rads, and for γ-rays was 106 ± 5.1 rads. The ratio of these values gave the relative biological effectiveness (RBE) which, for the comparison 14 MeV neutrons/^{60}Co γ, is 1.67 ± 0.06. (auth)

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Refer also to abstracts 43655, 43678, 43681, 43701, 43729, 43759, 43767, 43789, 43792, 43794, 43801, 43830, 43833, 43843, 43844, and 43923.

43886 CHANGES IN THE ANKLE JERK TIME DURING THE COURSE OF RADIOIODINE TREATMENT OF HYPERTHYROIDISM. Zamrazil, V.; Vana, S.; Nemec, J. (Research Inst. of Endocrinology, Prague). Rev. Fr. Etud. Clin. Biol., 14: 377-80 (Apr. 1969).

In 65 patients with hyperthyroidism following treatment with ^{131}I, the ankle jerk time was investigated at weekly intervals for a period of 5 to 7 weeks. No significant changes of the ankle jerk time were found in the group as a whole, nor after dividing it into subgroups according to previous treatment with carbimazole and according to the amount of radiation delivered to the thyroid tissue (up to 15,000 rads and above 15,000 rads). On classification by the initial ankle jerk time into two groups (up to 275 ms and 280 ms and longer), a significant prolongation from the third week onwards was found in the group with the initially more rapid ankle jerk times. The prolongation was however recorded only in subjects not treated previously with carbimazole. (auth)

43887 OVULATION INDUCTION WITH X RAYS. Gimenez Miranda, J. Martin; Farias Rodriguez, J. M. Ginecol. Obstet. Mex., 22: 11-19(Jan.-Feb. 1967). (In Spanish).

X radiation was administered to the hypophysis and ovaries of 43 patients between the ages of 20 and 29 years. The cycles of 70% were definitely regulated; 9% were temporarily regulated; and there was no regulation in 21%. The delay in regulation was between one and four months and 70% became pregnant. Among three patients who were given repeated treatments, one became pregnant on four occasions, another on two occasions, and in the third pregnancy resulted after one treatment with no result from the other treatment. Two patients older than 35 remained amenorrheic. One patient gave birth to a child with a hare lip five years after irradiation; she had had two normal children previously. The children of the other patients were normal. There was a total of four abortions. The time between treatment and pregnancy was one month for 7%, two months for 3%, three months for 44%, four months for 33%, five months for 3%, eight months for 7%, and twelve months for 3%. (tr-auth)

43888 MORPHOLOGICAL CHANGES IN INGUINAL AND PELVIC LYMPH NODES AFTER THE ADMINISTRATION OF ^{198}Au INTO LYMPHATIC VESSELS. Badmaeva, V. V.; Morozov, A. P. (Moscow Research Inst. of Oncology). Med. Radiol., 14: No. 8, 24-9(Aug. 1969). (In Russian).

Subject to radiometry and histological investigation were 297 lymph nodes: 54 pelvic and 243 of the inguinal region. The lymph nodes were removed at different periods after the administration of ^{198}Au into the lymphatic vessels of the dorsal side of patients with melanoblastoma of the skin of the lower extremities, cancer of the uterine cervix and head of the penis. The accumulation of the isotope in different groups of regional nodes is shown and the percentage of accumulation calculated. The degree of radiation injury of the lymphatic tissue depended on the absorbed dose. The tissue of melanoblastoma metastases did not include ^{198}Au. Low activity values were noted in sclerosed lymph nodes and nodes with fatty degeneration of the lymphoid tissue. There was noted a phenomenon of by-passing of these nodes by colloidal ^{198}Au along the lymphatic routes of the cellular tissue surrounding them. (auth)

43889 KINETIC STUDY OF LYMPHOCYTES BY EXTRACORPOREAL IRRADIATION OF THE BLOOD AND ANALYSIS OF CHROMOSOME ABERRATIONS. Field, E. O.; Dawson, K. D.; Dolphin, J. W.; Sharpe, Heather (Royal Mardsen Hospital, Sutton, Eng.). Nouv. Rev. Franc. Hematol., 8: 685-90(Sept.-Oct. 1968). (In French).

An extracorporeal technique for kinetic studies on lymphocytes in man was developed that avoids many difficulties encountered in other methods. In vivo isotope labeling procedures are costly and involve some radiation hazard. In vitro labeling, with re-infusion of lymphocytes, may introduce artefacts due to loss of label or to damage sustained during manipulation. The labeling procedure developed depends on irradiating the blood in an extracorporeal shunt and subsequently scoring chromosome aberrations induced in lymphocytes, stimulated to undergo mitosis by means of phytohemagglutinin. Analysis of dicentric yields obtained after a single transit of the irradiation coil and at intervals during and after a prolonged course of extracorporeal irradiation enabled determination of the size of extravascular lymphocyte pool, the rate of exchange of lymphocytes between the blood and this pool, and the life span of lymphocytes. Data were obtained in patients suffering from lymphoma subjected to extracorporeal irradiation with ^{137}Cs at a transit dose of 320 rad. (BBB)

43890 RADIOBIOLOGICAL FACTORS IN SPACE CONQUEST. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). Aerosp. Med., 40: 834-43(Aug. 1969).

The radiation effects on man during space flights are discussed and classified in relation to the parameters of time and extent of injury. The early effects of ionizing radiation are arbitrarily taken as those occurring within 30 to 60 days following exposure to relatively high doses (> about 50 rads). Early somatic effects relevant to space flight include: skin erythema and desquamation, prodromal response, hematological depression, early lethality, and decreased fertility and sterility. The late effects are those occurring only after many months or many years. They may result from a single high-intensity exposure or from gradual dose accumulation at low dose-rate over protracted periods. Late somatic effects relevant to spaceflight include; permanent or delayed skin changes, increased incidence of cataracts, increased incidence of leukemia or other neoplastic diseases, and general life shortening. Each of the early and late effects is discussed. (E.R.B.)

43891 PAROTIDOPATHY CAUSED BY IRRADIATION. I. SIALOGRAPHIC ASPECTS. Cecchetti, E.; Sassi, P. (Univ., Bologna). Oto-Rino-Laringol. Ital., 36: 239-67(1967). (In Italian).

The alterations of the sialographic pictures after irradiation of the parotid region with various doses and at different time intervals were studied. After a detailed description of the technique and the methodology of the research adopted to obtain a correct execution of the sialographic examination and a reliable comparison between different patients or in the same patient at various times, the authors submit a causistics including patients irradiated through conventional roentgentherapy, ^{137}Cs, ^{60}Co and 2 MeV Van de Graaff electrostatic generator for phlogistic or neoplastic or neoplastic extra-parotid processes. The sialographic pictures are divided into three groups: fibroplastic, nonfibroplastic and associated forms. Each radiogram is discussed from the semeiological viewpoint and the modifications are regarded as post-irradiatory sequel on the basis of a comparison with the radiological examination carried out before the radiological treatment. The term of radiation parotidopathy is proposed as the most suited to designate the remarkable polymorphism of the postirradiatory alterations. (auth)

43892 RADIODERMATITIS. Laymon, Carl W. (Univ. of Minnesota, Minneapolis). Minn. Med., 52: 833-4(May 1969).

Acute and chronic forms of radiodermatitis are described. First-degree radiodermatitis of the acute type consists of erythema with slight burning, itching, and scaling, which disappears after a few days or weeks. There may be temporary alopecia; pigmentation develops later. Edema, intense erythema, and vesiculation typify second-degree radiodermatitis, followed by exudation, erosion, and crusting. Loss of hair may be permanent. Sebaceous and sweat glands become less active. Atrophy and telangiectasia appear several months later. Necrosis and ulceration characterize third-degree radiodermatitis. Recovery may take several months; in some instances the ulcerations are indolent and never heal. The chronic type may develop after the acute type or insidiously as a result of many fractional (suberythema) doses. The skin is dry, thin, smooth, shiny, and sensitive to trauma. Itching and burning are prominent symptoms. Both hyper- and hypopigmentation and telangiectasis occur. The nails may be striated, discolored, brittle, or lost. As the disorder progresses, multiple keratoses appear. Carcinoma develops in about 20% of the cases, usually squamous rather than basal cell in type. Sarcoma may also arise in areas of radiodermatitis. Mild radiodermatitis responds to measures used for corresponding phases of dermatitis due to other causes. Ointments or creams containing a steroid and an antibiotic are helpful in first-degree radiodermatitis. If vesiculation is present, moist compresses of Burow's solution are effective. Severe cases, with necrosis and ulceration, require excision followed by grafting. (BBB)

43893 SOME PROBLEMS OF AVIATION AND SPACE MEDICINE. Levit, Pavel (ed.). Prague, Charles University, 1967. 225p. (In several languages).

Separate abstracts were prepared for six chapters on radiation effects. The physiological response of astronauts and aviation personnel to occupational biological stresses is discussed in twenty-nine additional chapters. (C.H.)

For abstracts of individual chapters see: 43655, 43674, 43767, 43787, 43801, and 43874.

43894 RADIATION ANGIOKERATOMA FOLLOWING GRENZ RADIATION. Abe, Yoshiko; Sugai, Tetsuro; Saito, Tadao (Osaka City Univ.). Arch. Dermatol., 100: 294-6(Sept. 1969).

A 45-year-old Korean man with lichen simplex chronicus on the scrotal skin was treated by overdosage of grenz radiation three years ago. A persistent, erythematopurpuric lesion with telangiectasia insidiously developed on the irradiated, hypermelanotic area six months after the final irradiation. A dark-reddish, sessile tumor appeared and gradually increased in size in the past three months. This was followed by the occurrence of three other similar tubers. Histologic findings of the tumors revealed those of angiokeratoma with acantholysis. It is an additional sequela of grenz radiation and also a warning to the unwary on the grenz-ray treatment. (auth)

43895 HOWELL-JOLLY BODIES IN NORMOBLASTS OF PERSONS EXPOSED TO THE HAZARD OF SMALL DOSES OF IONIZING RADIATION. Novakova, E.; Nosek, J. Cas. Lek. Cesk., 108: 318-20(Mar. 14, 1969). (In Czech).

The number of normoblasts in bone marrow containing Howell-Jolly bodies was studied. A group of miners working underground, mining radioactive raw materials and a group not exposed to this hazard were compared. Both groups differ mutually. The control group had on an average 5.3 ± 2.2 cells with Howell-Jolly bodies per 5000 normoblasts. This is 1.06% of the total number of normoblasts. The group of miners had 9.3 ± 3.6 cells with Howell-Jolly bodies per 5000 normoblasts. This is 1.86% of the total number of normoblasts. The method of choice for detection of

Howell–Jolly bodies in normoblasts is to stain smears of bone marrow panoptically as recommended by Unno-Papenheim. Feulgen's method is not a routine method and is not quite reliable. (auth)

43896 LATE EFFECTS OF ARTIFICIAL MENOPAUSE BY X-RADIATION. Brinkley, Diana; Haybittle, J. L. (Addenbrooke's Hospital, Cambridge, Eng.). Brit. J. Radiol., 42: 519-21(July 1969).

Two hundred and seventy-seven patients treated by an x-ray menopause in the period 1942 to 52 have been followed up for an average of 16.1 years. The number of deaths from different causes were compared with the numbers reported from a similar population analyzed in the mortality rates published by the Registrar–General for the Eastern Region of England and Wales. It was found that there was a significantly increased mortality from all causes in the treated group and that this was mainly attributable to an increase of deaths from cancer at heavily irradiated sites occurring more than five years after treatment. There was also a significant increase in deaths from coronary disease, myocardial degeneration and cerebrovascular disease within five years of treatment. A comparison of the incidence of cancer with the numbers to be expected calculated from the registration at the Cambridge Cancer Registration Bureau, showed a significantly increased incidence of cancer of heavily irradiated sites occurring more than five years after treatment. There was no reduction in the incidence of breast cancer, and there were no cases of leukemia. (auth)

43897 MULTIPLE PAGETOID EPITHELIOMA APPEARING IN AN AREA FORMERLY STRONGLY IRRADIATED BY X-RAYS. Colomb, D.; David, D. Bull. Soc. Fr. Dermatol. Syphiligr., 75: 525-6(1968). (In French).

The case of a multiple pagetoid epithelioma of the lumbo-sacral region in a 62 year-old woman of good general health otherwise was described. She had had an episode of sciatic lumbago at the age of 18, which was treated over a 2-year period by a lumbo-sacral therapy in 32 sessions. At the age of 42 pigmented regions appeared in this area, which were diagnosed as epithelioma and treated with radiotherapy. The patient discontinued the treatment against medical advice, and then sought it again at the age of 62. The results of the cutaneous examination were reported. The two largest pigmented areas were removed by electrodissection. (J.S.R.)

43898 ANALYSIS AND RESULTS OF PLASTIC SURGERY OF 59 CASES OF RADIATION ULCERS. Erdelyi, R. Acta Chir. Orthopaed. Traumatol. Cech., 35: 524-30(Dec. 1968). (In Czech).

A series of 59 cases of radiation ulcer from the etiological and therapeutic aspect are presented. Ulcers developed in 5% following diagnostic irradiation, in 35% following the treatment of benign skin affections and in almost 58% in cases of malignancy. Professional exposure caused not quite 2% of ulcers. The development of such ulcers following the diagnostic use of x-rays and following treatment of nonmalignant disorders could be avoided, provided correct dosage was used. In malignant disease, however, where intervention is vital, damage to the skin can at present not always be avoided, a trained radiologist must be in charge of therapy by radiation. Treatment most commonly consisted of skin transplantation with the fatty layer intact to ensure healthy material with an adequate blood supply facilitating healing of the ulcer and coverage of the defect. Malignant evolution was observed in two cases. All ulcers could be permanently cured. (auth)

43899 OUR EXPERIENCES WITH THE X-RAY TREATMENT OF INFLAMMATORY EYE DISORDERS OF THE ANTERIOR BULBAR SEGMENT. Ambruss, E.; Busch, Zs.; Grosz, I. v.; Hajdu, I. (Janos Metropolitan Hospital, Budapest). Acta Ophthalmol., 47: 339-45(1969). (In German).

A low frequency of side-effects from irradiation was reported after treatment of dacrocystitis, blepharitis, superficial keratitis, leukoma and vascularization of the cornea, epithelialization in the anterior chamber after cataract removal, recurrent scleritis and uveitis, tuberculous iridis, and myositis. Only two out of 53 patients showed transient dermatitis of the eyelids following irradiation with 10- to 30-KV x ray, given in daily doses of 30 to 100 R, and totaling up to as much as 800 R total dose. Massive reactive conjunctival hyperemia appeared within 2 or 3 days of the start of the treatments, but did not last for longer than 1 week. (BBB)

43900 THE STATE OF CEREBRAL CIRCULATION IN INTERNAL IRRADIATION WITH ^{134}Cs AND ^{137}Cs. Glazunov, I. S.; Grafov, A. A.; Ivanov, V. A. Med. Radiol., 14: No. 6, 3-8(June 1969). (In Russian).

Acute radiation injury caused by the internal exposure to radioactive cesium in the human organism resulted in the development of peripheral and cerebral vascular dystonia, which was confirmed by means of rheovasography and orbital plethysmography. Intracerebral dystonia supervened much later and coincided in time with the appearance of separate pathological symptoms in the neurological state. It is necessary to further accumulate facts testifying to the possible relation between changes in the regional cerebral circulation and clinical manifestations of lesion of the nervous system in acute radiation injuries. (auth)

43901 THE FUNCTIONAL STATE OF THE THYROID GLAND, HYPOPHYSIS, AND ADRENAL CORTEX IN CHRONIC EFFECT OF IONIZING RADIATION. Gorbarenko, N. I.; Smirnova, M. I.; Strygina, T. A. (Inst. of Industrial Sanitation and Occupational Disease, Moscow). Med. Radiol., 14: No. 6, 64-70(June 1969). (In Russian).

Studies on the functional state of the thyroid gland, adrenal cortex, and diencephalohypophyseal region were conducted in 302 persons contacting ionizing radiation in the process of occupational activity. As controls, 108 persons were used in whom the function of the thyroid gland was impaired along with 21 apparently healthy persons—the function of the adrenals were assessed. The indices were compared with the irradiation dose and features peculiar to the clinical syndrome—a type of vegetative-vascular dystonia. The investigations revealed no profound disturbance in the state of studied indices of the activity of glands of internal secretion. There were noted only slight functional deviations in the thyroid gland, increased absorption of radioiodine by the gland, which in a number of cases corresponded to the clinical syndrome of its functional disturbance. There were established functional alterations of the adrenal cortex in the form of reduction of their potential functional reserves, mainly revealed against the background of employment of functional loadings. (auth)

43902 CARCINOMA OF THE THYROID WITH LEPTOMENINGEAL DISSEMINATION FOLLOWING THE TREATMENT OF A TOXIC GOITER WITH ^{131}I AND METHYL THIOURACIL: CASE WITH A CO-EXISTING INTRACRANIAL DERMOID. Barnard, R. O.; Parsons, M. (Maida Vale Hospital, London). J. Neurol. Sci., 8: 299-306(Mar.-Apr. 1969).

A case of thyroid carcinoma arising after radioiodine therapy is reported and the possible role of irradiation in tumor induction is discussed. The patient, a 69-yr-old woman, had been treated for thyrotoxic cardiac failure. The basal metabolic rate of +24% and a protein-bound ^{131}I of 1.99% (normal less than 0.3%) confirmed that the goiter had become toxic. Full recovery followed treatment with digoxin, diuretics, and methyl thiouracil, but in February 1962 the patient was given a single dose of 5000 μCi of ^{131}I. The following year she developed headache, vomiting, sleepiness, diplopia, inability to walk, and pulsation over the thyroid. At autopsy, metastatic thyroid carcinoma and intracranial dermoid were found. The appearance of toxicity and then malignancy in a nodular goiter is unusual; possibly a differentiated carcinoma of some years' standing eventually became anaplastic. On the other hand, the anaplastic change could be iatrogenic, since experimentally ^{131}I can induce malignant changes in glands rendered hyperplastic with neomercazole, and thyroid carcinoma has been considered a potential long-term hazard of treating thyrotoxicosis with ^{131}I. (BBB)

43903 THYROID DISEASE FOLLOWING THE ADMINISTRATION OF THOROTRAST. Langlands, A. O.; Hermann, Kate (Western General Hospital, Edinburgh). J. Clin. Pathol., 20: 892-5(Nov. 1967).

Examination of 35 patients who had received intra-arterial Thorotrast revealed a higher incidence of thyroid disease than might have been expected by chance. Attention is drawn to this finding and details of 5 cases are given. Four cases of thyrotoxicosis developed in patients given Thorotrast during investigation of intracranial hemorrhage. In this group Thorotrast had been given between 11 and 31 yr (mean 23.4 yr) previously. Thyrotoxicosis occurred in 4 patients between 6 and 17 yr (mean 11.8 yr) after the injection of Thorotrast. The fact that thyrotoxicosis did not occur in a small control group of patients who had had a subarachnoid hemorrhage and in whom Thorotrast had not been used at angiography suggests that Thorotrast may be of etiological significance. In view of the known association between thyrotoxicosis and changes in the lymphoreticular system, it is possible that the irradiation of this system by retained Th resulted in an abnormality of function which renders these patients more liable to the development of thyrotoxicosis. A fifth patient developed nontoxic thyroid enlargement 16 yr after Thorotrast angiography. The amount of Thorotrast injected in the cases developing thyroid disease was not significantly different from the mean value of 25.5 ml. (BBB)

43904 RETICULOCYTES IN THE BLOOD OF MINERS WORKING IN URANIUM MINES. Novakova, E.; Nosek, J.

(Industrial Inst. of Public Health, Pribram, Czech.). Cas. Lek. Cesk., 108: 797-8(June 20, 1969). (In Czech).

The results of an examination of the blood of uranium miners are described; the average reticulocytosis of the miners did not differ from results obtained in a control group. The changes observed in the blood of people exposed to ionizing radiation consisting of the rate of change of methemoglobin inside of red blood corpuscles are not caused by changes in the reticulocytosis of the circulating blood. (JPRS)

43905 RADIATION MYELITIS IN CARCINOMA OF THE NASOPHARYNX. Tan, B. C.; Khor, T. H. (Outram Road General Hospital, Singapore, China). Clin. Radiol., 20: 329-31(July 1969).

Cases of radiation myelitis were observed as a complication of radiotherapy of the head and neck region. Treatment of nasopharyngeal carcinoma generally involves exposing the spinal cord to a considerable dose of radiation especially where the treatment is repeated. Of 22 cases of carcinoma of the nasopharynx which were irradiated twice, three cases of radiation myelitis have been observed. Case reports of two of these cases are produced. This does not give the true incidence of radiation myelitis as the follow-up of cases is not complete. A discussion on the diagnosis and prognosis of this condition is given and comment is made of the incidence of myelitis in other series of nasopharyngeal carcinoma treated with radiation. (auth)

Radiation Effects on Plants

Refer also to abstracts 43684, 43719–43721, 43728, 43740, 43743, and 43744.

43906 (BNL–13763) RESPONSES IN MUTATION, GROWTH INHIBITION, TUMORIZATION, AND ISOZYME MULTIPLICITY FROM EXPOSING SEEDS TO IRRADIATION OF DIFFERENT LINEAR ENERGY TRANSFER. Smith, H. H.; Hirono, Y.; Conklin, M. E.; Lyman, J. T. (Brookhaven National Lab., Upton, N. Y. Adelphia Univ., Garden City, N. Y. California Univ., Berkeley). [1969]. 26p. (CONF-690703-6; SM-121/35). Dep. CFSTI.

From Symposium on the Nature, Induction, and Utilization of Mutation in Plants, Pullman, Wash.

Seeds of a genetic stock of Arabidopsis thaliana and of three genotypes of Nicotiana (two species and their tumor-prone amphiploid) were irradiated. The irradiations ranged in linear energy transfer (LET) from 2 keV/μ (250 kVp x rays) to 1890 keV/μ (argon ions). The responses measured were somatic mutations, tumorization, various manifestations of growth inhibition, and the production of peroxidase isozymes. The relative biological effectiveness (RBE) for all criteria measured, including mutations, was highest at LET's of 74 to 172 keV/μ. This indicated a common primary target, the genetic material, for each effect. The dose of fission neutrons relative to 250 kVp x rays to produce an equal effect (regardless of criteria) maintains a simple power function relationship with a slope of between one and two. As a consequence, the RBE is inversely related to absorbed dose so that genotypes or criteria that are affected by low doses give relatively high RBE's and vice versa. The production of multiple forms (isozymes) of peroxidases is enhanced by irradiation, is dose dependent, is relatively more affected per unit dose by neutrons than by x rays, and provides a readily measurable response to irradiation at a molecular level. (auth)

43907 SIMILARITIES BETWEEN A UV-SENSITIVE MUTANT OF YEAST AND BACTERIAL MUTANTS LACKING EXCISION-REPAIR ABILITY. Kilbey, B. J.; Smith, Sheena M. (Univ. of Edinburgh). Mol. Gen. Genet., 104: 253-7(July 3, 1969).

A uv-sensitive and a wild-type strain of Saccharomyces cerevisiae were compared with respect to their responses to photoreactivation, retention of the capacity to photoreactive when stored at 32°C in buffer, and sensitivity to diepoxybutane and nitrosoguanidine. In all these tests the behaviour of the sensitive mutant paralleled bacterial strains lacking excision repair ability. We may tentatively attribute the uv-sensitivity in this mutant to a loss of some element of a repair system analogous to excision repair in bacteria. (auth)

43908 EFFECT OF UV-RADIATION ON RHIZOSPHERE FUNGI OF HEALTHY AND VIRUS-INFECTED PLANTS OF CHENOPODIUM AMARANTICOLOR COSTE AND REYN. Mishra, R. R. (Univ., Gorakhpur, India). Experientia, 25: 657(June 15, 1969).

Healthy and virus infected plants of Chenopodium amaranticolor were exposed to uv radiation and, subsequently, the fungi content of the rhizosphere was analyzed. Ultraviolet radiation changed the fungal flora as to quality and quantity. (H.B.G.)

43909 RESISTANCE OF THE DARK-COLORED FUNGI STEMPHYLIUM BOTRYOSUM WALLR. AND CLADOSPORIUM CLADOSPORIOIDES (FRIES) DE VRIES TO γ RADIATION. Mirchink, T. G.; Kashkina, G. B.; Abaturov, Yu. D. (Lomonosov State Univ., Moscow). Microbiology (USSR) (Engl. Transl.). 37: 724-7(Sept.–Oct. 1968).

Gamma irradiation of various strains of fungi showed that the unpigmented strain, Gliocladium fimbriatum, differed greatly in sensitivity to irradiation from the four strains of dark-colored fungi tested. A dose of 25 kR substantially reduced the percentage survival of this species. The survival rate of G. fimbriatum after irradiation at a dose of 25 kR was only 24% of that in the control, whereas 250 kR was almost totally lethal to the culture. All the strains of pigmented fungi of the family Dematiaceae investigated were substantially more resistant to γ irradiation than the unpigmented form. Their reactions to doses of 25 and 125 kR were less than those of the unpigmented cultures. Doses below 25 kR had no effect on their survival rate. The percentage survival of the dark-colored fungi was 40 to 60% of that in the control at 25 kR and 30 to 45% at 125 kR. A survival rate of 10 to 30% was observed after irradiation at a dose of 250 kR, while three of the four strains remained viable after 625 kR. Among the dark-pigmented fungi, a greater difference in radioresistance was observed between species of different genera than between species obtained from different ecological settings. The most resistant strains were of the species Stemphylium botryosum and the least resistant were of the species Cladosporium cladosporoides of the two strains tested of each species. The more resistant forms were from high-altitude mountain soils and the less resistant were from lowland soils of the podzolic zone. The predominance of dark-pigmented fungi in mountain soils may be related to their greater resistance to ionizing radiation than unpigmented forms. (BBB)

43910 STUDIES ON THE FLOWER INITIATION IN PHARBITIS SEEDLINGS. 4. INFLUENCES OF LOCALIZED X- OR GAMMA-IRRADIATION. Wada, Kiyomi (Shizuoka Univ., Japan). Bot. Mag. (Tokyo), 82: 1-5(Jan. 1969).

Acute moderate doses of ionizing radiations given to the whole plant exert a pronounced influence on the initiation and development of flower primordia in Pharbitis seedlings. However, they had no effect when the irradiation was restricted to the cotyledons or cotyledonary petioles, or when the plumule was shielded from the radiation by a lead bar. This implies that the ionizing radiations directly inhibit the initiation and development of flower primordia in the plumule. Very strong x rays (40 kR to 100 kR) applied to the cotyledonary petioles inhibited flowering when the radiation was given 12 to 16 hours after the beginning of the dark period, the time when the floral stimulus might be passing through the petiole. (NSA of Japan)

43911 ANTIRADICAL ACTIVITY OF TISSUE AND RADIOSENSITIVITY. Kuzin, A. M.; Gaziev, A. I. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR, 184: 221-4(Jan. 1, 1969). (In Russian).

Tissues always contain substances with a high reducing potential, which are active electron and proton donors. Many of these substances are active scavengers of free radicals, and should have radioprotective properties. Thus there should exist an inverse dependence between the concentration of antiradicals in a tissue and its radiosensitivity. To test this hypothesis the antiradical activity of tissues was investigated from the ability to reduce the stabile free radical, alpha-alpha-diphenyl-beta-picryl-hydrazil (DPPH). This method can be used to determine up to 0.1 to 0.5×10^{-6} moles of antiradicals, and is very specific. Roots of the bean, pea and clover were rapidly fixed in liquid nitrogen, and samples were reacted with DPPH. The bean which was the most radiosensitive showed a high antiradical activity, while the radioresistant clover showed a low antiradical activity. These data show that the higher the concentration of reducing agents of short-lived radicals in a tissue, the greater is the probability of occurrence of long-lived radicals in a cell, which play such a definite role in determining the radiosensitivity of the organism. (TTT)

43912 β-RAY SPLIT-DOSE RECOVERY IN DIPLOID YEAST IN HYPOXIC CONDITIONS. Kiefer, J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 223: 405-6(July 26, 1969).

It was known that recovery from sublethal damage by ionising radiation is considerably reduced or prevented if organisms are kept in hypoxic conditions between irradiations, and the reason for this has been assumed to be dependence of the recovery process on metabolic energy; but since experimental work in this connection was conducted with organisms incapable of anaerobic fermentation it appeared desirable to study split-dose recovery in cells which can live and divide anaerobically as well as aerobically. This may be relevant to radiotherapy, since many hypoxic

cells in tumors may be capable of anaerobic glycolysis. With this in mind, studies were made with diploid yeast. Irradiation was with a 12 MeV electron linear accelerator at a dose rate of ~1 kR/sec to a dose of 100 kR given either as a single exposure or in two equal fractions at various time intervals, in air. Uninterrupted and split-dose exposure resulted in the same recovery. Since the medium contains glucose the yeast cells were able to satisfy their energy requirements both aerobically and anaerobically, and the results provide some evidence that recovery from sublethal damage is connected with the energy metabolism of the cell. (UK)

43913 RBE OF RADIATIONS IN E-1 HOLE OF KYOTO UNIVERSITY REACTOR (KUR). Matsumura, Seiji; Amano, Etsuo; Hayashi, Masaru (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 107-8(1967).

Dry seeds of rice and Einkorn wheat were irradiated in the E-1 exposure hole under nitrogen gas or air atmosphere. Results of seedling height measurement of the reactor-irradiated rice seeds showed that 50% seedling height reducing doses were obtained at 21 cm for nitrogen gas and 22 cm for air atmosphere, from the core side end of the E-1 sample holding boat, revealing the distinctly protective effect of nitrogen. Wheat seedling height measurement on the seventh day after sowing also revealed an oxygen effect. Calculations of RBE of the reactor thermal neutrons free of contaminating γ rays were attempted for the 50% seedling height reducing dose, assuming that the contaminating γ rays in E-1 radiations might have the same RBE as that of ^{137}Cs γ rays. Under an air atmosphere, the difference in γ rays was 2000 rad, an effect of which was comparable to 131 rad of thermal neutrons, giving an RBE value of 15.3. Efficiency of the γ rays might be reduced under nitrogen atmosphere; the difference in γ rays was 5000 rad and equivalent effect might be brought about by 181 rad of thermal neutrons, giving an RBE value of 28.3. Under the same assumption of the efficiency of γ rays, it was considered that 131 rad of thermal neutrons reduced the final 13% of the seedling height to reach 50% height of the control in case of air, and 181 rad reduced the final 17% for a nitrogen atmosphere, to give 50% height, suggesting the same efficiency of thermal neutrons in seedling height reduction regardless of the atmosphere. As for RBE values of overall E-1 radiations relative to ^{137}Cs γ rays, 1.12 for exposure in air and 1.35 in nitrogen were obtained. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 43703, 43704, 43724, and 43730.

43914 BACTERIOPHAGE-INDUCED INHIBITION OF HOST FUNCTIONS. II. EVIDENCE FOR MULTIPLE, SEQUENTIAL BACTERIOPHAGE-INDUCED DEOXYRIBONUCLEASES RESPONSIBLE FOR DEGRADATION OF CELLULAR DEOXYRIBONUCLEIC ACID. Bose, Subir K.; Warren, Richard J. (St. Louis Univ.). J. Virol., 3: 549-56(June 1969).

Degradation of bacterial deoxyribonucleic acid (DNA) after infection with T4 bacteriophage was studied in an endonuclease I-deficient host. The kinetics of degradation were similar to those seen in other hosts with a normal level of this enzyme. Irradiation of extracellular phage with ultraviolet (uv) destroyed the capacity of the infecting virus to induce extensive breakdown of host DNA, that was, however, converted to high-molecular-weight material. Addition of chloramphenicol to T4-infected cells provided data that can be interpreted to indicate the involvement of at least two endodeoxyribonucleases and one exodeoxyribonuclease having a high degree of specificity. A model is proposed showing the sequential action of two endodeoxyribonucleases followed by an exodeoxyribonuclease in the degradation of host DNA. The appearance of these hydrolytic enzymes requires protein synthesis. Infections leading to partial degradation only (uv-irradiated phages, gene 46 mutants) effectively inhibited the synthesis of bacterial messenger ribonucleic acid and of β-galactosidase. (auth)

43915 EFFECT OF ULTRAVIOLET IRRADIATION AND ACTINOMYCIN D ON POLYOMA VIRUS REPLICATION IN MOUSE EMBRYO CELL CULTURES. Bowen, J. M.; Hughes, R. G.; Dmochowski, L. (Univ. of Texas, Houston). J. Virol., 3: 570-7(June 1969).

Ultraviolet (uv) irradiation and actinomycin D impair the capacity of mouse embryo (ME) cells to support the replication of polyoma virus, but not of encephalomyocarditis (EMC) virus. The loss in capacity for polyoma virus synthesis was an all-or-none effect and followed closely upon the loss in cellular capacity for clone formation. Cells treated with either agent produced polyoma T antigen, but did not synthesize polyoma structural protein. Infection of untreated ME cells with polyoma virus produced marked stimulation of both deoxyribonucleic acid (DNA) synthesis and ribonucleic acid (RNA) synthesis. ME cell cultures irradiated with uv for 30 sec at 60 $\mu w/cm^2$ or treated with actinomycin D at 0.1 $\mu g/ml$ for 6 hr prior to infection were incapable of synthesizing DNA or RNA, even after infection with polyoma virus. Irradiation of cells during infection produced cessation of synthesis of both RNA and DNA. Addition of actinomycin D during infection did not inhibit DNA synthesis but abolished RNA synthesis and reduced the yield of polyoma virus to 10% of that in untreated infected cultures. Both agents lost the ability to prevent replication of a full yield of polyoma virus when administered 30 hr after infection or later. The period after which neither agent inhibited polyoma replication corresponded with the period at which maximal RNA synthesis in untreated infected cultures had subsided. It can be concluded on the basis of the data presented that the functional integrity of the mouse embryo cell genome is required for the replication of polyoma virus, but not for EMC virus. Whereas the requirement for cellular DNA-dependent RNA synthesis for polyoma virus replication was demonstrated, the exact nature of the host-cell function remains to be elucidated. (auth)

43916 GENETIC ANALYSIS OF tox^+ AND tox^- BACTERIOPHAGES OF CORYNEBACTERIUM DIPHTHERIAE. Holmes, Randall K.; Barksdale, Lane (New York Univ., N. Y.). J. Virol., 3: 586-98(June 1969).

A series of mutants derived from the temperate corynebacteriophages β^{tox+}, γ^{tox-}, and L^{tox+} was isolated and characterized. In three-factor crosses between mutant β phages the relative map order of the genetic markers determining extended host ranges (h and h') and loss of ability to lysogenize (c) was found to be h–c–h'. Recombination between markers was observed in matings between phage β and the heteroimmune corynebacteriophages γ and L. In such matings between heteroimmune phages the c markers of phages β and γ failed to segregate from the imm markers that determine the specificity of lysogenic immunity in these phages. The factor that directs the synthesis of diphtherial toxin during infection of appropriate corynebacterial hosts by toxinogenic corynebacteriophages is designed tox^+. It was possible to show that the tox^+ determinant of phage β behaves as a single genetic element that occupies a position between the loci h and imm on the genetic map of this phage. Genetic recombination between mutants of phage β occurred at very low frequencies in biparental matings performed by mixed infection of Corynebacterium diphtheriae $C7_s(-)^{tox-}$. Considerably higher recombination frequencies were observed when lysogenic bacterial strains carrying one parental phage as prophage were induced by uv irradiation and then superinfected by the second parental phage. Maximal stimulation of genetic recombination between mutant β phages was detected when superinfection followed uv irradiation of the lysogenic cells within a limited period of time. In matings between phages with incomplete genetic homology, the stimulation of recombination by uv radiation was much less effective. (auth)

43917 COMPARATIVE ANALYSIS OF VEGETATIVE AND SPORE FORMS OF AZOTOBACTER FOR RESISTANCE TO HEAT. Craxi, M.; Ferrara, M. G.; Ferina, F. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 44: 1856-60 (Nov. 30, 1968). (In Italian).

The heat resistance of vegetative and spore forms of azotobacter was determined before and after exposure to ultraviolet radiation to observe the phenomenon of sensitization to heat reported for E. coli and S. aureus. The results showed that the spore form is the more heat resistant. Ultraviolet radiation causes a heat sensitization in both forms. (J.S.R.)

43918 OBSERVATIONS ON RESISTANCE OF VEGETATIVE AND SPORE FORMS OF AZOTOBACTER TO THE EFFECTS OF ALCOHOL. Craxi, M.; Ferrara, M. G.; Ferina, F. (Univ., Palermo, Italy). Boll. Soc. Ital. Biol. Sper., 44: 1860-4 (Nov. 30, 1968). (In Italian).

A comparative examination was made of the effects of uv radiation on the resistance of the vegetative and spore forms of Azotobacter to the effect of ethyl alcohol. The results showed a greater resistance of the spore form to the effects of ethyl alcohol. Alcohol at concentrations of 75% had a greater extractive capacity than solutions of greater and less concentration. (J.S.R.)

43919 NONVIABLE VENEZUELAN EQUINE ENCEPHALOMYELITIS HEMAGGLUTININ PREPARED FROM TISSUE CULTURES BY GAMMA RADIATION. Reitman, Morton (Medical Sciences Labs., Fort Detrick, Md.). Appl. Microbiol., 18: 278-9 (Aug. 1969).

Hemagglutinins of Venezuelan equine encephalomyelitis virus were produced in tissue cultures, and the infective virus was rendered nonviable by exposure to gamma radiation. (auth)

43920 INDUCTION OF λ PROPHAGE. Cowlishaw, John David. University Park, Pa., Pennsylvania State Univ., 1968. 116p. Thesis.

The present study has attempted to elucidate the mechanism of induction of prophage. Three questions were asked: What is the inducing lesion? What is the mechanism by which the initial inducing lesion is transformed into depression of the prophage? and Why do larger treatments with inducing agents generally inactivate the plaque forming ability of cells potentially induced by smaller treatments? It was contended on the basis of results in the literature that radiation induction is due to lesions in the host DNA that lead, via host metabolic processes, to the production of inducer molecules that render nonfunctional the phage repressors in the cell. The notion that DNA lesions are the cause of induction is supported by the correlation in radiation sensitivities between colony forming ability and induction of cells of various repair potentials. In addition, induction of lysogens containing the phage mutant λt1 is sensitized both to uv (as also shown by others) and to γ rays, suggesting the presence of subinducing concentrations of inducer molecules in lightly irradiated but uninduced (λ) lysogens. Studies were also conducted with nalidixic acid (NA) that appears to be a specific and reversible inhibitor of DNA synthesis, allowing a quantitative correlation between the fraction of cells induced and the length of inhibition of DNA synthesis. NA treatment of Escherichia coli W3350(λ) grown in minimal medium caused induction of essentially all the cells of a culture. NA did not produce stable chemical lesions in the DNA; however, the inhibition of DNA synthesis led to some inducing event. An investigation of the kinetics of induction by NA indicated that: the inducing event occurs in some cells immediately upon the inhibition of DNA synthesis, the production of inducing events occurs in the population of cells at a rate that is proportional to the length of DNA synthesis inhibition, the rate is proportional to the concentration of NA up to about 20 μg NA/ml, thereafter increasing as less than the first power, the induction rate is about seven-fold faster for lysogens of the uv-induction-sensitive prophage λt1, the induction rate is substantially reduced for 40 min after amino acid starvation of the lysogens, the NA inactivation of plaque forming ability of NA-induced cells is due to the deleterious effect of NA on phage DNA synthesis, concomitant protein synthesis is necessary to obtain induction with NA, but chloramphenicol does not block the deleterious effect of NA on phage DNA synthesis, and the lethal effect of NA on the colony forming ability of bacteria is similar in the defective-prophage-containing Escherichia coli 15T⁻ and its cured derivative JG151. Results suggest that a population of cells is not homogeneous in its sensitivity to NA and that the heterogeneity results from the variety of cell ages in a normal population. Two hypotheses concerning the nature of the inducing event are described. Jacob and coworkers have suggested that the inducer is an adenine-related molecule that builds up in concentration during DNA synthesis inhibition. An alternative hypothesis is proposed in this thesis that implicates premature replication inhibition events and/or false reinitiation events in an indirect buildup of some small molecule, released or malformed by abnormal replication events. The phage repressor, it is proposed, has adapted evolutionarily to recognize this danger signal. Both hypotheses are consonant with a heterogeneity in induction sensitivity and with the results obtained in the present study. However, related phenomena — similarities between filament formation and prophage induction, low spontaneous induction frequencies, persistence of induction-favoring events, and the involvement of the rec gene — are taken as evidence for the latter hypothesis. (Disser. Abstr.)

43921 EFFECT OF ULTRAVIOLET IRRADIATION AND ACTINOMYCIN D ON POLYOMA VIRUS REPLICATION IN MOUSE EMBRYO CELL CULTURES. Bowen, J. M.; Hughes, R. G.; Dmochowski, L. (Anderson Hospital and Tumor Inst., Houston, Tex.). J. Virol., 3: 570-7(June 1969).

Ultraviolet irradiation and actinomycin D impair the capacity of mouse embryo (ME) cells to support the replication of polyoma virus, but not of encephalomyocarditis (EMC) virus. ME cell monolayer cultures were irradiated with a germicidal lamp at a uv intensity of 60 μw/cm² for 15, 30, or 45 sec. Immediately after irradiation, replicate cultures were tested for capacity to clone or to support the replication of polyoma or EMC virus. The loss in capacity for polyoma virus synthesis was an all-or-none effect and followed closely upon the loss in cellular capacity for clone formation. Cells treated with either agent produced polyoma T antigen, but did not synthesize polyoma structural protein. Infection of untreated ME cells with polyoma virus produced marked stimulation of both DNA and RNA synthesis. ME cell cultures irradiated with uv for 30 sec or treated with actinomycin D at 0.1 μg/ml for 6 hr prior to infection were incapable of synthesizing DNA or RNA, even after infection with polyoma virus. The uv irradiation of cells during infection produced cessation of synthesis of both RNA and DNA. Addition of actinomycin D during infection did not inhibit DNA synthesis but abolished RNA synthesis and reduced the yield of polyoma virus to 10% of that in untreated infected cultures. Both agents lost the ability to prevent replication of a full yield of polyoma virus when administered 30 hr after infection or later. The period after which neither agent inhibited polyoma replication corresponded with the period at which maximal RNA synthesis in untreated infected cultures had subsided. It was concluded that the functional integrity of the mouse embryo cell genome is required for the replication of polyoma virus, but not for EMC virus. (BBB)

43922 EFFECTS OF GAMMA RADIATION ON WESTERN EQUINE ENCEPHALOMYELITIS AND TICK-BORNE ENCEPHALITIS VIRUSES. Hruskova, J. (Military Inst. of Hygiene, Epidemiology, and Microbiology, Prague). Acta Virol. (Prague), 13: 187-92(May 1969).

Effects of γ radiation on the infectivity and antigenicity of two viruses were examined. The viruses were irradiated at doses up to 3 Mrad at a dose rate of 4 Krad/min. Irradiation with 2 to 3 Mrad caused complete loss of infectivity of Western equine encephalomyelitis (WEE) and tick-borne encephalitis (TE) viruses in medium 199 containing 2% calf serum. The WEE virus titer started to decrease after a dose of 10^5 rad and after about 2 Mrad the virus was completely inactivated. Only exceptionally were traces of virus found after irradiation with up to 2.6 Mrad, but after irradiation with 3 Mrad not even traces of live virus were demonstrated. The TE virus titers started to decrease on irradiation with 10^5 rad and complete inactivation occurred with about 2 Mrad. At a dose of 2.5 Mrad, not even traces of live virus were demonstrated. The rate of inactivation depended on the medium; it decreased somewhat with increased serum concentration. Lyophilized viruses were inactivated with a dose of 4 Mrad. Complete inactivation of the viruses by irradiation occurred before spontaneous virus inactivation had started. Samples irradiated with a dose of 4 Mrad showed decreased antigenicity in guinea pigs and mice. (BBB)

43923 THE MICROFLORA OF THE BRONCHIAL CONTENTS AFTER RADIUM THERAPY OF LUNG CANCER. Nesenyuk, T. A. (Central Research Inst. of Roentgenology and Radiology, Moscow). Med. Radiol., 14: No. 6, 19-23(June 1969). (In Russian).

Changes of the microflora of the bronchial contents in 43 patients with lung cancer in the process of radium therapy were studied using the washing from the bronchial mucosa of the affected lung. A prevalence of Staphylococcus was found. During irradiation in a number of cases the microflora of the respiratory tract changed its composition, antibiotic sensitivity, and pathogenicity. The great accuracy of bacteriological investigation of the bronchial contents by means of the method of bronchial washings in comparison with microbiological investigation of the sputum is pointed out. (auth)

Radiosterilization and Radiopreservation

43924 (NP-tr-1833) DO IRRADIATED FOODSTUFFS HAVE A RADIOMIMETIC EFFECT? Bugyaki, L.; Deschreider, A. R.; Moutschen, J.; Moutschen-Dahmen, M.; Thijs, A.; Lafontaine, A. Translated by O. S. Whitston (Atomic Energy Research Establishment, Harwell, Eng.) from Atompraxis, 14: 112-18(1968). 13p. Dep. CFSTI (U. S. Sales Only).

The effects of γ radiation on the physical and chemical properties of flour are described. Addition of irradiated flour to the food of mice caused some distinct pathological changes, especially in regard to fertility and longevity. Tumor incidence was higher in mice fed irradiated food and there was a significant increase in chromosome aberrations. Techniques for cytogenetic studies on testes are described, and aberrations of chromosomes in metaphase, anaphase, and telophase are analyzed in detail. (H.L.W.)

43925 (ORNL-IIC-11(Suppl.2)) RADIATION PASTEURIZATION OF FRUITS AND VEGETABLES. A Bibliography. Weiss, F. J. (comp.) (Library of Congress, Washington, D. C.); McKinney, F. E. (ed.) (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 21p. Dep. CFSTI.

This bibliography is the second supplement provided to information on this topic. An author and a subject index are provided for the 167 references. (C.O.)

43926 (ORNL-IIC-20) CENTRALIZED PROCESSING OF FRESH MEAT AND POULTRY INCLUDING RADIATION PASTEUIZATION. A Bibliography. Urbain, W. M.; Belo, P. S.; Giddings, G. G. (comps.) (Michigan State Univ., East Lansing); McKinney, F. E. (ed.) (Oak Ridge National Lab., Tenn.). Apr. 1969. Contracts W-7405-eng-26; AT(11-1)-1689. 71p. (COO-1689-3). De. CFSTI.

The entries in this bibliography are divided into the following subject categories: radiation pasteurization of fresh meat and poultry and related radiation references (287 references); retailing and wholesaling of fresh meat and poultry including centralized cutting (35 references); pigment and color of fresh meat and poultry (69 references); fluid exudation and water holding capacity of fresh meat and poultry (93 references); general microbiology of fresh meat and poultry (95 references); and related patents (10 references). An author and a subject index are provided. (C.O.)

43927 (ORNL-tr-2026) FOOD PRESERVATION BY IRRADIATION. V. ECONOMIC STUDY OF THE POTATO MARKET IN SPAIN AND POSSIBILITIES OF PRESERVING POTATOES BY IRRADIATION. Rivas, A.; Garcia de Mateos, A.; Ortin Sune, N.; de Val Cob, M. (Junta de Energia Nuclear, Madrid (Spain)). Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report JEN-184-SI/I-17. 20p. Dep. CFSTI.

The possibilities of using γ radiation to process potatoes in Spain were investigated. Data are presented on the annual production, consumption, and importation of potatoes. It was concluded that potato production is sufficient to supply the national market provided adequate methods for preservation and improved marketing practices are developed for potatoes. (C.H.)

43928 EFFECTS OF INTRODUCED IRRADIATED MALE GRAIN MITES ON POPULATION DEVELOPMENT. Brown, Gary A.; Davis, Robert (Univ. of Georgia, Athens). J. Econ. Entomol., 62: 767-71(Aug. 1969).

The use of ^{60}Co γ-irradiated males in initiating populations of Acarus siro L. revealed an increased inhibition of population development with increased irradiation dose. There was no significant difference in total population development between the control and populations started with males irradiated with 5 krad. A significant difference was observed between populations started with males irradiated at 5 krad and 15 krad. Attempts to reduce the development of a normally growing population by flooding it with irradiated males in a 10:1 (irradiated:non-irradiated) ratio proved to be unsuccessful. Without the influence of immature mites at the time of flooding, the irradiated males proved to be effective in reducing population development through an inhibition of normal mating activities. (auth)

43929 RELEASES OF UNSEXED GAMMA-IRRADIATED CODLING MOTHS FOR POPULATION SUPPRESSION. White, Leland D.; Hutt, Robert B.; Butt, B. A. (Agricultural Research Service, Yakima, Wash.). J. Econ. Entomol., 62: 795-8(Aug. 1969).

Release of unsexed sterile Laspeyresia pomonella (L). and one prerelease spray of parathion, reduced fruit injury in a small orchard from about 50% in 1965 to 1.57% in 1966. The adult moths were sterilized (at 4°C by 40 krad from ^{60}Co), marked, and released 6 days per week from May 16 to Sept. 14. Approximately 60,000 moths were released in the orchard, a semi-isolated block of 24 apple and 5 pear trees at Yakima, Washington. This procedure resulted in an average ratio of 23 sterile: 1 native male as measured by sex and light traps. (auth)

43930 EFFECT OF IRRADIATION ON MATING PREFERENCE AND REPRODUCTION SUPPRESSION OF DROSOPHILA MELANOGASTER. Mason, Horatio C.; Papageorgiou, Mary C.; Jacklin, Stanley W. (Agricultural Research Service, Beltsville, Md.). J. Econ. Entomol., 62: 818-21(Aug. 1969).

In laboratory studies during 1964 and 1965 with adult Drosophila melanogaster Meigen untreated males showed no mating preference between untreated and treated (^{60}Co γ irradiated) females, the reproductive potential was suppressed more by introduction of treated males into a population than by introduction of treated females, and suppression of reproduction in a population was about the same when treated males and females or treated males only were introduced. (auth)

43931 NUTRITIVE COMPOSITION OF IRRADIATED GULF OYSTERS STORED IN ICE. Liuzzo, Joseph A.; Lagarde, Stephen C.; Novak, Arthur F. (Louisiana State Univ., Baton Rouge). J. Agr. Food Chem., 17: 764-6(July-Aug. 1969).

Radiation preservation of Gulf oysters was reported to be feasible in past studies on the basis of organoleptic, chemical, and bacteriological tests when doses of 0.2 Mrad were employed. In this study, freshly shucked oysters were divided into three treatments: nonirradiated, irradiated at 0.2 and 0.4 Mrad with ^{60}Co, and iced-stored for 0, 5, 10, 15, and 20 days. At these intervals, the oysters were analyzed for moisture, ash, glycogen, crude protein, nonprotein nitrogen, true protein, crude fat, and soluble sugars. Crude protein was the only nutrient significantly affected by irradiation. When this fraction was converted to true protein, the significance of the decrease was lost. Ash content was significantly decreased as storage time increased. Although not significant, glycogen decreased and soluble sugars increased during storage. Because none of the major nutrients was greatly affected, the feasibility of radiation preservation of oysters is strengthened. (auth)

43932 CHEMICAL TO NUCLEAR. Lamade, Wanda. Agr. Chem., 23: 18-20(May 1968).

Use of a portable ^{137}Cs irradiator to inhibit sprouting of potatoes is described. An exposure of 70-sec to give a dose of 15 Krad was used. The irradiated potatoes remained in good condition for up to 2 yr at 72°F storage. This dose has been approved by the FDA for sprout inhibition in potatoes. Studies are also being conducted on the use of γ radiation to control soft rot leak and other damaging micro-organisms in potatoes. If the 15-Krad dose will also control these organisms, one exposure of the potatoes should inhibit sprouting and control the microorganisms. The small prototype portable demonstration unit built for AEC by American Nuclear cost about $95,000. The irradiation machine weighs 18 tons (mostly in the lead shielding) and this is installed on a 35-ft trailer. The irradiation chamber is large enough to hold two 18 × 14 × 7-in. trays. Stationary units are in operation at research projects. In these units, water shields operating personnel. Commercial development of this process for inhibition of potato sprouting and other applications of γ radiation in the food industry are discussed, with emphasis on legislation needed for more widespread use of radiation treatment of food. (BBB)

43933 EXPERIMENTS ON THE USE OF SPICES STERILIZED BY IONIZING RADIATION IN THE MEAT INDUSTRY. Incze, Kalman; Farkas, Jozsef (Orszagos Husipari Kutatointezet, Budapest. Elelmiszeripari Kutatointezet, Budapest). Atomtech. Tajek., 11: 405-11(Aug. 1968). (In Hungarian).

The spore number of spices could be lowered by ionizing radiation by a few order of magnitude; this effect is observable in the integral spore number of the end product meat. Organoleptic changes do not occur. The microflora of irradiated spices becomes more sensitive to heat and sporostatic factors than that of non-irradiated ones. (TSS)

43934 INVESTIGATION OF RADIATION AUTOCIDE METHOD IN HUNGARY. Jermy, Tibor; Nagy, Barnabas (Noevenyvedelmi Kutato Intezet, Budapest). Atomtech. Tajek., 11: 661-4(Dec. 1968). (In Hungarian).

Investigations were conducted on radiosterilization of the following insects: cockchafer (Melolontha melolontha), bean weevil (Acanthoscelides obtectus), apple moth (Carpocapsa pomonella), plum moth (Laspeyresia funebrana), maize moth (Ostrinia nubilasis), and fleecy moth (Lymantria dispar). The sterile male technique was also considered for other fruit moths, species of Lepidoptera, and flies. (auth) (TSS)

43935 INVESTIGATIONS IN HUNGARY ON THE APPLICATION OF IONIZING RADIATIONS IN FOOD INDUSTRY. Kiss, Istvan (Koezponti Elelmiszeripari Kutatointezet, Budapest). Atomtech. Tajek., 11: 665-70(Dec. 1968). (In Hungarian).

Studies on radiosensitivity of the flour beetles, Tribolium confusum and Tyrophagus dimidiatus, revealed that imagoes were killed by 12 to 25 krad and that their reproductive ability was considerably decreased by 3 krad. Reproduction of mites was prevented by doses of 25 to 50 krad. Microorganisms in barley and wheat were destroyed by doses of 50 to 100 krad. The storage time of strawberries was increased by 200 to 300 krad. The process of ripening of peaches was increased by a dose of 50 krad. Other investigations were conducted on radiosterilization of spices and sugars and radiosensitivity of bacterial spores and yeasts. (auth) (TSS)

43936 PROLONGATION OF STORAGE TIME OF CULTIVATED MUSHROOM BY IONIZING RADIATION. Kovacs, Etelka; Vas, Karoly; Farkas, Jozsef (Koezponti Elelmiszeripari Kutatointezet, Budapest). Atomtech. Tajek., 11: 349-54(July 1968). (In Hungarian).

The storage time of champignon mushrooms after irradiation with a dose of ca. 25 krad and stored in freezers with +5°C had been prolonged from 3 to 9 days. Irradiation inhibits the opening of the head of mushrooms, lowers weight losses during storage, and does not evoke organoleptic changes, but by slowing down processes helps in preserving taste and aromatic materials. (TSS)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 43455, 43473, 43492, and 44000.

43937 THE EFFECT OF DEFECTS ON MECHANICAL PROPERTIES OF ARTICLES AND WELDS. pp 258-79 of Industrial Radiology. Rumyantsev, S. New York, Gordon and Breach, Science Publishers, [1969].

Information is presented on the effects of defects of metallurgical origin on the strength of articles, effects of welding quality on the strength of welds, and workability of steel and duraluminum. (J.R.D.)

43938 REAKTORNOE MATERIALOVEDENIE. (Reactor Material Science). Skorov, D. M.; Bychkov, Yu. F.; Dashkovskii, A. I.; Chepkunov, V. V. Moscow, Atomizdat, 1968. 388p.

Nuclear fuels and the effects of radiation and fission energy on them are discussed. The properties of metals, ceramics, and dispersion-type fuels were examined, and the changes in their mechanical and physical properties during reactor operation described. The bases for neutron physics, reactor physics, and the transformation of fission energy into thermal energy are clarified. The properties of cladding and structural materials are discussed in relation to fuel reactions with cladding and different coolants. Methods for fabrication of reactor core materials, sealing of cladding, as well as methods for testing the fuels are described. (421 referencs) (tr-auth)

43939 ZrHf NEWSLETTER, JULY 1969. Akron, N. Y., Amax Specialty Metals, Inc., 1969. 16p.

A review of research results on properties and uses of Hf and Zr is presented. Properties of alloys containing Hf are reported along with properties and uses of hafnium boride. Properties of alloys containing Zr are also reviewed along with those of the oxides, hydrides, borides, and carbides of Zr. 204 references are included. (J.R.D.)

43940 CONTINUOUS COMPILATION OF NEW REFERENCE DATA ON DIFFUSION PROCESSES IN INORGANIC SOLIDS AND THEIR MELTS. Diffus. Data, 3: 119-260(Aug. 1969).

The references are grouped under diffusion in solid metals and alloys, diffusion in molten metals and alloys, diffusion in oxides, diffusion in halides, and diffusion in miscellaneous substances. (J.R.D.)

43941 EFFECT OF SPACE ENVIRONMENT ON MATERIALS. Shemilt, H. R. Electron. Components, 10: 936-9(Aug. 1969).

Data on the effects of space environments on materials are briefly reviewed, and two major factors involved—very high vacuum and damage by visible and invisible particles are discussed. Data on the effects selection of metals, polymers, and other materials are tabulated. (auth) (UK)

Corrosion and Erosion

Refer also to abstract 45078.

43942 (CONF-680510-(Absts.)) 1968 AEC CORROSION SYMPOSIUM, MAY 6-8, 1968, BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO. Program and Abstracts. (Battelle Memorial Inst., Columbus, Ohio). 59p. Dep. CFSTI.

Abstracts of papers presented at the symposium on corrosion of reactor materials by Li and Na, solubility of reactor materials in Na, and corrosion of reactor materials by fused salts are collected. Information is also included on Zr corrosion, stress-corrosion, and fuel cladding compatibility. (J.R.D.)

43943 (GEAP-5719) SODIUM COMPONENTS DEVELOPMENT PROGRAM. MASS TRANSFER INVESTIGATIONS IN LIQUID METAL SYSTEMS. Quarterly Progress Report No. 7, September-November 1968. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jan. 1969. Contract AT(04-3)-189. 94p. Dep. CFSTI.

Activities in programs to determine corrosion and mass transfer rates under conditions of interest in the design of large LMFBR systems and FFTF are reported. Data and information resulting from operation of corrosion loops 8 and 9 are presented. Materials exposed in these runs, which were conducted using Na at 1300, included Types 304, 316, and 347 stainless steel and Incoloy 800. Research directed toward a method of determining the levels of impurities in sodium which affect corrosion mechanisms is also reported. Efforts during the report period were devoted to establishing temperature profiles, analyses of plugging indicator data, and overall loop performance experience. Other work is reported on mechanical limits for cladding materials including Types 304, 316, and 347 stainless steel and Incoloy 800. (J.R.D.)

43944 (GEAP-10008) SODIUM COMPONENTS DEVELOPMENT PROGRAM MASS TRANSFER INVESTIGATIONS IN LIQUID METAL SYSTEMS. Quarterly Progress Report No. 8, December 1968-February 1969. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Apr. 1969. Contract AT(04-3)-189. 44p. Dep. CFSTI.

Studies involving steel exposed to Na revealed that corrosion rates were found to be weakly dependent on mass flow at 1300°F, approximately 2,000 hours, and 3 ft/sec velocity. Mass flow was varied by a factor of two in a specially designed corrosion cartridge in which two values of mass flow were obtained at the same velocity. Saturation of iron in the sodium was established by negligible weight losses of ARMCO iron samples. The effect of heat-flux on corrosion was further investigated. An electron-bombardment (EB) heater was operated continuously in loop 9 for 1250 hours at about 172 watts/cm^2 (~500,000 Btu/hr-ft^2) heat flux with 1300°F bulk sodium outlet. Hydrogen compounds have been found to be the main cause of low temperature breaks in the plugging curve as well as the high temperature breaks. An unexpected result was the near absence (<5%) of sodium oxide. This work confirms that a plugging temperature is not uniquely related to the oxygen concentration in a sodium system. Particulates causing plugging of the orifices at low temperature were identified as sodium hydride and sodium hydroxide. The cyanide concentration was investigated in the hot and cold-legs of loop 9 to determine the degree of saturation. Less than 1 ppM of cyanide was found in samples removed at temperatures from 755 to 1230°F (solubility of CN is >100 ppM at 1100°F). Stress-rupture test results show that initial microstructural condition of Type-304 SS does not have significant effect on stress-rupture properties for the range of structures tested at 1300°F for 3600 hours. Type-316 SS showed a strong effect due to initial structure. After a carbide agglomeration heat treatment, a 100% increase in time-to-rupture was found compared with mill annealed material. A 10,000-hour stress-rupture run was started in loop 4R at 1300°F involving annealed and carbide agglomerated specimens of types 304 and 316 stainless steel. (J.R.D.)

43945 (WAPD-Trans-120) HIGH-TEMPERATURE OXIDATION OF ZIRCONIUM AND BINARY ZIRCONIUM ALLOYS WITH SMALL CONCENTRATIONS OF ADDITION ELEMENTS. De Gelas, B.; Beranger, G.; Lacombe, P. (Ecole Nationale Superieure des Mines, Paris (France). Centre de Recherches Metallurgiques). Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from report. 54p. Dep. CFSTI.

The effects of binary additions of Cu, Cr, Fe, Mo, Al, Nb, and Sn on the oxidation of Zr-base alloys at 750 were examined. Stages of oxidation are described as the initial stage governed by a complex kinetic low, a parabolic stage in which the oxidation rate is controlled by the diffusion of oxygen through the oxide layer, and a final stage involving fissure formation and peeling. (J.R.D)

43946 STRUCTURE OF OXIDE FILMS FOUND ON TANTALUM SURFACE BY WET OXIDATION. Nakayama, Tadayuki; Osaka, Toshiaki. Rep. Cast. Res. Lab., Waseda Univ., No. 18, 29-33(Nov. 1967).

99.97% Ta samples were heated in an autoclave in water or water vapor to 300°C for 1 or 24 hr. The resultant surface films were studied by transmission electron diffraction. Both films were of the rutile type; that formed in water was identified as tapiolite, (Fe, Ta)O_2 and that in water vapor as TaO_2. (Metals Abstr.)

43947 PITTING AND CONTACT CORROSION IN MAGNESIUM-CLAD FUEL ELEMENTS. Thomas, M.; Webel, J. Werkst. Korros., 19: 895-900(Oct. 1968). (In German).

During storage of spent fuel elements in water the risk of contact corrosion exists between Mg and graphite and if chlorides are present even in traces, pitting and corrosion occurs. A hydroxide layer is formed only above a pH of 11.5 and gives some protection. The pitting corrosion potential in alkaline water becomes more negative with increasing chloride content which can be prevented by inhibitors, such as Na carbonate. (UKAEA Info. Bull.)

43948 OXIDATION OF NIOBIUM SINGLE CRYSTALS. Stringer, J. (Univ. of Liverpool). Acta Met., 17: 1227-46(Oct. 1969).

Single crystals of niobium in the form of ¼-in. dia spheres have been oxidized in dry oxygen at approximately 400 torr pressure in the temperature range 550 to 925°C. The results indicate that suboxide platelets are present at temperature below 600°C, and produce lines of pores in the scale, as reported for tantalum. The lines of pores produce characteristic scale failures. At 550 and 600°C the reaction rate is anisotropic. Above 600°C the platelets are absent, and the modes of scale failure are quite different; the oxidation appears to be completely isotropic. (auth)

43949 ON THE OXIDATION OF Zr–Nb 2 PERCENT ALLOY. Tsirlin, M. S.; Khvorostinina, N. M.; Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim., No. 3, 80–5(May–June 1969). (In Russian).

Zirconium stability in oxygen was found to deteriorate with the addition of niobium especially at the temperature above that of α to β transition in the Zr–Nb alloy. The mechanism of oxidation at 550 to 950°C and P_{O_2} = 740 torr has been suggested. Oxygen diffusion in alloy and phase composition of the scale formed upon oxidation has been studied. (auth)

43950 THERMAL OXIDATION OF SPUTTERED TANTALUM THIN FILMS BETWEEN 100° AND 525°C. Steidel, C. A.; Gerstenberg, D. (Bell Telephone Labs., Inc., Allentown, Pa.). J. Appl. Phys., 40: 3828–35(Aug. 1969).

Results are presented for the thermal oxidation behavior of four types of sputtered tantalum films between 100 and 525°C. These films are bcc tantalum, β-tantalum, a porous β-tantalum, and tantalum nitride (Ta_2N). All four types of films show parabolic oxidation kinetics and the formation of adherent Ta_2O_5 (tantalum oxy-nitride for Ta_2N films) with bright interference colors. The first three types of films dissolve about 12 at. % oxygen, which is much higher than the oxygen solubility found in bulk tantalum, and the films show a different degree of suboxide formation than bulk tantalum. The activation energies for oxygen diffusion in the metal and for oxide growth are 1.2 and 1.4 eV, respectively. The dielectric properties of the thermal oxide are discussed in terms of the defects in the oxide. (auth)

43951 GROWTH OF CRACKS WITHIN BRITTLE ZIRCONIUM HYDRIDE PLATELETS CONTAINED IN A DUCTILE ZIRCONIUM MATRIX. Beevers, C. J.; Warren, M. R. (Univ. of Birmingham, Eng.). pp 360–71 of Proceedings of the 2nd International Conference on Fracture, Brighton, England, April 1969. Pratt, P. L. (ed.). London, Chapman and Hall, 1969.
See CONF-690423.

The tensile behavior of a two-phase material consisting of randomly oriented brittle zirconium hydride platelets in a ductile zirconium matrix was studied at −196°C. Surface metallographic examinations made during interrupted tests revealed the following observations: Two distinct stages in the fracture of the hydride platelets could be distinguished. These were (a) the nucleation and formation of cracks transverse to the major dimensions of the platelets, and (b) the formation of in-plane cracks which propagated in directions parallel to the major dimensions of the platelets. Stage (a) was related to the intersection of the platelets by matrix twins and slip bands, but Stage (b) did not occur until the spacing of the transverse cracks was of the order of the platelet thickness. The initial formation of the in-plane cracks was apparently controlled by a normal stress condition, but the later part of the crack growth in this stage was closely related to the overall plastic strain of the material. It was noted that at a constant plastic strain the larger the platelets the longer the in-plane cracks contained within them. Increasing grain size and hydrogen content resulted in larger hydride platelets, and the enhanced embrittlement at −196°C under these conditions could be directly related to the increase in length of the in-plane cracks introduced into the ductile matrix. (auth) (UK)

43952 EFFECT OF MATERIAL STRESS-STRAIN PROPERTIES ON FATIGUE FAILURE. Tomkins, B.; Sumner, G.; Wareing, J. (United Kingdom Atomic Energy Authority, Springfields, Eng.). pp 712–24 of Proceedings of the 2nd International Conference on Fracture, Brighton, England, April 1969. Pratt, P. L. (ed.). London, Chapman and Hall, 1969.
See CONF-690423.

A theoretical treatment is made of the high strain fatigue mechanism of crack propagation in ductile metals, using a continuum method involving the distribution of plastic cohesive stresses at the crack tip. From the analysis, the well known low endurance fatigue laws of crack propagation and endurance (the Coffin-Manson law) are derived. The rate of crack growth at any instant is shown to depend on the bulk stress-strain properties of the material at that instant and the state of stress in the crack tip deformation zone. The basic material parameters which control the fatigue life of a metal are thus defined. The theory was shown to be valid for simple fatigue failure at room temperature in several metals and alloys. An experimental study was made at room and elevated temperature on a stainless steel involving various combinations of fatigue and tensile straining. In particular, the cases of tensile prestrain followed by fatigue cycling and fatigue cycling under a continuously increasing tensile strain were studied and confirmed the theoretical predictions of endurance under such conditions. (auth) (UK)

43953 THE CHEMICAL CORROSION OF LEAD ALLOYS. Royuela, J. J.; Gonzalez, J. A.; Feliu, S. Rev. Met. (Madrid), 5: 3–8(Jan.–Feb. 1969). (In Spanish).

A series of binary, ternary, and quaternary Pb alloys with Ag, Al, As, Ba, Bi, Ca, Cd, Cu, Li, Na, Sb, Te, and Tl were exposed to distilled H_2O and air or to 5% acetic acid for 100 days. The rate of corrosion in H_2O was governed by the formation of a corrosion product film and varied with the alloy, the best groups containing Sn–Ca or Sn–Ba. No film was formed in acetic acid; the rate of attack was linear and not limited by alloying elements. (Metals Abstr.)

43954 ZIRCONIUM–ZIRCONIA INTERFACE. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Aust. Inst. Metals, 14: 123–31(Aug. 1969).

The zirconium-zirconia interface was studied with both conventional and scanning electron microscopes using specimens of crystal-bar zirconium and Zircaloy-2 oxidized in water, steam, or oxygen at temperatures of 250 to 650°C. Polished sections, etched to reveal the inner interface of the oxide, were examined and no evidence was found for attack of the etching solution on the oxide. Variations in the roughness of the interface with time and temperature were observed for both materials, but only zirconium showed any significant effect due to the oxidizing medium. Several distinct scales of roughness were observed in the range resolvable using the SEM; but the greater resolution of the replica technique revealed no smaller characteristic features, and the interface appeared rounded without faceting. The topography of the interface agrees with that predicted by a hypothesis whereby fresh oxide, forming by inward migration of oxygen, is amorphous and subsequently crystallizes. The development of a columnar morphology in thicker oxides determines the macroscopic roughness of the interface, which does not appear to be influenced by the stresses generated during growth. (Australia)

Preparation and Fabrication

Refer also to abstracts 43990 and 44773.

43955 (CONF-680506–, pp 73–95) ZERO POWER REACTOR FUEL FABRICATION AND QUALITY CONTROL. Shuck, A. B. (Argonne National Lab., Ill.).

The largest single requirement for plutonium to date is the 4,000 kilograms being fabricated into various fuel elements for the liquid-metal, fast-breeder-reactor physics and critical experiments. The programs for the procurement of the plutonium have included fuel-element and fabrication process development, prior to preparation of specifications. After negotiation of fuel fabrication contracts, the contractors' process procedures and quality-control plans are qualified by evaluation of a pilot-production lot of fuel elements. Representatives maintain a continuing audit of the contractor procedures and inspections. Production, quality-control, and analytical data received from the contractor are statistically evaluated and compared with results from the ANL receiving inspection. Compositional data on each element are coded on punch cards that are used in programming the reactor loadings. (auth)

43956 THE INFLUENCE OF THE WELDING THERMAL CYCLE AND TEMPERING ON THE STRUCTURE AND RESISTANCE TO BRITTLE FAILURE OF CHROMIUM–MOLYBDENUM–VANADIUM WELD METAL. Shron, R. Z.; Nebesova, I. F. Avtomat. Svarka, No. 12, 39–44(Dec. 1968). (In Russian).

Tests were made on 12Kh1MF steel tube. Three preheating temperature ranges were used: 150 to 200, 300 to 350, and 450 to 500°C. Wide and narrow beads were used in the test with specific energies of 3260 and 7340 cal/cm. The structure and properties of the as-welded metal, and after tempering at 680°C for 3 hr and 730°C for 3 hr were studied. Impact tests using Charpy V-notch specimens were carried out in the temperature range −60 to +60°C to determine the resistance to brittle failure. The brittleness transition temperature (t_k) was determined in relation to the welding thermal cycle and tempering temperature. Absence of tempering or a reduction of the tempering temperature by 50°C increases the tendency of the metal to brittle failure, displacing t_k towards the higher temperature. The mean value of t_k increases by 30 to 40°C in the absence of tempering. The tendency to brittle failure increases with increase in the preheat temperature and is par-

ticularly noticeable in the tempered condition. Weld metal preheated to 450 to 500°C with a wide bead had the minimum resistance to brittle failure. t_k in this case was 40 to 60°C and did not change after tempering. An increase in the preheat temperature to 450 to 500°C is not desirable. In those cases where it is difficult to avoid such heating, e.g., with different metal thicknesses, the weld should be made with a narrow bead and a specific energy not more than 3500 to 4000 cal/cm. (Metals. Abstr.)

43957 THE EFFECT OF HEAT TREATMENT ON THE PROPERTIES OF JOINTS BETWEEN ZIRCONIUM–2.5 PERCENT NIOBIUM ALLOY AND NIOBIUM ALLOYS. Novosadov, V. S. Avtomat. Svarka, No. 1, 26-9(Jan. 1969). (In Russian).

The basic process which causes embrittlement of welded joints between Zr–1 to 2.5% Nb and Nb alloys is the $\beta \rightarrow \omega$ transformation. The heat treatment proposed restores the ductility of such joints. The investigations showed that the best heat-treatment is annealing in a vacuum at 600°C and holding for 36 hr. Welded joints between electron-beam-melted Nb and Zr–2.5% Nb, made by electron-beam welding gave an increased bending angle of 90° and the impact strength increased to 4 kgf m/cm^2; the impact strength after Ar-arc welding increased to ~2.5 kgf m/cm^2. At this temperature and holding time the resolution of the ω-phase is more complete and a more stable structure and phase composition is obtained than by treatment at 500°C for 6 hr. The strength of welded joints with both heat treatments is controlled, independent of the test temperature, by the strength of the base metal with the lower UTS value. Heat treatment of the joints should be carried out <20 to 30 hr after welding, during which time the welded joint has a satisfactory reserve of ductility. (Metals Abstr.)

43958 HOW TO CAST COBALT-BASE SUPERALLOYS. Woulds, Michael J. Precis. Metal, 27: No. 4, 46–7, 97(Apr. 4, 1969).

Raising the casting temperature of MAR-M alloy 509 caused an increase in grain size and rupture life and a decrease in min. creep rate in the metal, but an increase also in mold attack or reactivity. A metal superheat at about 300°F over the melting point of the alloy minimizes mold attack and optimizes properties. However, mold reactivity becomes a real problem when casting thick sections in molds made of refractories containing Zr. A modified MAR-M 509 with a lower Zr content, obviates this problem; it can be air-melted with very little loss of properties as compared with the standard, vacuum-melted grade. Larson–Miller curves show that MAR-M 509, even in the air-melted condition, is stronger than several other Co-base superalloys. The application of these findings to melting practice has led to superior oxidation resistance and wider applications of MAR-M 509, for example, in gas turbine engines. (Metals Abstr.)

43959 ELECTROSLAG WELDING OF A CoCrW ALLOY WITH THE WELD-TORCH ZIS 439 A. Irmer, W.; Mueller, E. ZIS (Zentralinst. Schweisstech.)-Mitt., 11: 115-24(Jan. 1969). (In German).

Electroslag welding of a 60% Co–24% Cr–1.25% C–4.4% W–2.2% Si alloy was studied. Susceptibility of the build-up layers to cracking and porosity formation was determined and the weld was examined metallographically. Microhardness measurements across the deposited weld were taken. Results showed that the weld-torch was suitable for electroslag welding. The quality of the deposited bead depended on the powder used. While crack formation could be limited by a suitable heat treatment, it was not possible to produce deposited layers free from porosity. (Metals Abstr.)

43960 EXTRACTION OF IRON USING ATOMIC ENERGY. Wenzel, Werner. Klepzig Fachber., 77: 105-9(Feb. 1969). (In German).

Although the main use of atomic energy will probably be to provide electrical energy for heating purposes it is foreseen that the heat produced in nuclear reactors will be used directly in iron making. This would avoid the inefficient conversion of heat in electrical energy. The use of direct heat in the extraction of iron will, however, require the development of nuclear reactors working at 1200 to 1500°C. The various stages involved in the extraction are examined in some detail and the economics considered. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 43430, 43989, 44539, 44551, 44552, and 45069.

43961 (BNWL–1112) YIELD SURFACE OF A URANIUM–7.5 WT PERCENT Nb–2.5 WT PERCENT Zr ALLOY (MULBERRY). Hays, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

The biaxial yield surface of a gamma stabilized uranium–7.5 wt % Nb–2.5 wt % Zr alloy (Mulberry) was determined. The yield surface is best described by the maximum strain (Von Mises) theory of yielding. (auth)

43962 (COO–1477-11) DEVELOPMENT OF TEST PROCEDURES. FRACTURE TOUGHNESS OF REACTOR PRESSURE VESSEL STEELS. Final Report. Crosley, P. B.; Ripling, E. J. (Materials Research Lab., Inc., Glenwood, Ill.). Mar. 1969. Contract AT(11-1)-1477. 39p. Dep. CFSTI.

The effect of loading rate on fracture toughness of A533 steel was studied. Dynamic loading was found to elevate the yield strength to an extent that resulted in a significant decrease in the specimen size required for measuring valid plane strain toughness. The direct influence of rate on K_{Ic}, however, was modest. The minimum specimen dimensions suggested by the ASTM E-24 Committee for high strength metal appears to be too conservative for this intermediate strength steel. Dimensions less than half the recommended ones were able to separate size-dependent from size-independent toughness values. The effect of specimen thickness at each of the testing temperatures could be described by the Irwin K_{Ic}-K_c-β_c relationship. Using this expression, a K_{Ic} value for infinitely thick specimens was defined, and this value was consistent with the lower bound of arrest toughness for tests made at +75, 0, and −75°F. (auth)

43963 (LA–4173) RHENIUM EFFECT IN SINTERED TUNGSTEN–MOLYBDENUM-BASE ALLOYS. Lenz, W. H.; Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). Apr. 15, 1969. Contract W-7405-eng-36. 13p. Dep. CFSTI.

A brittleness test is described which is useful in quantitatively measuring the limited ductility of sintered tungsten-base alloys. Subsequently, numerous sintered tungsten–molybdenum–rhenium compositions were evaluated to establish alloys which combined room-temperature ductility with a melting point above 2900°C. Ductility trends of the alloys were related to sintering temperature, molybdenum and rhenium content, and ThO_2 additive. The fusion temperatures of 18 alloys were determined. (auth)

43964 (ORO–3291–13) APPLICATION OF ADIABATIC CALORIMETRY TO METAL SYSTEMS. Progress Report, September 1, 1968–July 30, 1969. Stansbury, E. E.; Brooks, C. R. (Tennessee Univ., Knoxville. Dept. of Chemical and Metallurgical Engineering). July 1969. Contract AT(40-1)-3291. 32p. Dep. CFSTI.

Activities directed toward assessment of the accuracy of thermophysical measuring techniques used in heat capacity determinations are reported. This program involves about 40 laboratories and measurements on pure Cu, Au, Pt, W, Al_2O_3, and stainless steel for intercomparison. Results on Au measured during the report period are included. Research on short-range ordering in Ni-base Cr alloys continued during the report period. Data are included on specific heat of Ni–Cr alloys having different compositions. In other work the heat capacity-temperature curve for disordered Ni_3Fe was measured. (J.R.D.)

43965 (SC-DR-69-491) EXPERIMENTALLY DETERMINED DYNAMIC SHEAR STRENGTH FOR SELECTED MATERIALS (GUN TEST FACILITY). Biffle, J. H.; Berry, R. E. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 22p. Dep. CFSTI.

Cylindrical projectiles were impacted on selected materials to permit the calculation of the materials dynamic shear strengths. The materials were beryllium, Haynes-25 alloy, and titanium (6Al-4V) alloy which are the materials of construction for the SNAP-27 graphite lunar module fuel cask and fuel capsule assembly. (auth)

43966 DIFFUZIONNYE PROTSESSY V METALLAKH. (Diffusion Processes in Metals). Svechnikov, V. N. (ed.). Respublikanskii Mezhvedomstvennyi Sbornik, Metallofizika No. 25. Kiev, Naukova Dumka, 1968. 96p.

The results of experimental and theoretical studies on diffusion and the diffusion processes in metallic systems are presented. The effects of diffusion on welding and annealing of irradiated metals are discussed, as well as its effects on spheroidization and coalescence of dispersed phases and the behavior of vacancies in crystals at high temperatures. (104 references). (tr-auth)

43967 THEORY OF LOW TEMPERATURE WORK-HARDENING OF BODY-CENTERED CUBIC METALS. Takeuchi, Tomoyuki (National Research Inst. of Metals, Tokyo). J. Phys. Soc. Jap., 27: 436–43(Aug. 1969).

Stress-strain curves of bcc metals at low temperatures, where screw dislocations predominate, are calculated for crystals with the [100] deformation axis. The main assumptions are (1) an in-

crease of flow stress is proportional to the square root of forest dislocation density, (2) dislocations are multiplied by the cuttings of screw dislocations with repulsive elastic interaction, and (3) a screw annihilates with another dislocation with the opposite sign. The calculated stress-strain curve is compared with the observed stress-strain curves. It is concluded that the important property of screw dislocations in bcc metals is the easiness of cross-slip; this is the origin of the variety of the work-hardening in bcc metals at low temperatures. (auth)

43968 DETERMINATION OF THE EXACT COMPOSITION OF URANIUM–NIOBIUM ALLOYS. Djuric, Branko. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 7, 63-71(Sept. 1968).

Electron probe microanalysis was employed to determine the exact composition of niobium in a series of uranium–niobium alloys in which a part of niobium was bound by carbon in form of carbide. Best results were achieved with uranium Mβ line. The atomic number correction is very important in this system. Experimental values of the coefficient α produce better results than calculated values. (auth)

43969 SOLID SOLUTION STRENGTHENING AND WEAKENING OF B.C.C. SOLID SOLUTIONS. Arsenault, R. J. (Univ. of Maryland, College Park). Acta Met., 17: 1291-7(Oct. 1969).

Tension and compression tests were conducted on single crystal samples of tantalum and tantalum-base solid solutions as a function of temperature and strain rate. The activation parameters were investigated as a function of stress and strain. In considering the solid solution effects it is necessary to take into account the division that is made of the yield or flow stress into the two components. These two components are: a thermal component called the effective stress, and an athermal component. The thermal component may increase or decrease due to a solute addition, but the athermal component only increases due to a solute addition. The change in the thermal component of the yield stress due to niobium and tungsten addition to tantalum can readily be accounted for by a change in a Peierls' stress due to a change in the modulus of the alloy. However in the case of tantalum–rhenium the strengthening is much greater than that which can be accounted for by an increase in the Peierls' stress as a result of the increase in the modulus of the alloy. Of the possible mechanisms considered, the double kink mechanism can best account for the large increase in the thermal component if "demixing" is assumed for the tantalum–rhenium alloy. (auth)

43970 DYNAMIC COMPRESSION OF POROUS TUNGSTEN. Boade, R. R. (Sandia Labs., Albuquerque, N. Mex.). J. Appl. Phys., 40: 3781-5(Aug. 1969).

Data are presented from a study conducted to examine the shock-loading behavior of a sintered porous tungsten with a density of 12.64 g/cm^3 (corresponding to 65.3% of the density of solid tungsten). The experiments were performed by using a gas gun and high explosives. Hugoniot data obtained in the stress range between about 12 kbar and 1 Mbar indicate that compression of the porous material to a fully compacted state is essentially complete at 50 kbar. Above this level, a predicted Hugoniot, calculated from the Hugoniot of solid tungsten by using the Mie–Grüneisen equation of state, agrees well with experimental data. Below 50 kbar the Hugoniot of the porous tungsten deviates from the predicted Hugoniot increasingly with decreasing stress. Propagated wave profiles at lower stresses are characterized by two precursor waves, the faster being a low-level wave (~0.2 kbar) traveling at about sonic velocity in the porous tungsten (~3.04 mm/μsec). The slower precursor has an amplitude of 2.73 kbar and travels at 2.02 mm/μsec. The behavior of this porous tungsten is analogous to the behavior of sintered porous copper previously studied. (auth)

43971 STRENGTH AND ALLOY SOFTENING IN BCC METALS. Ravi, K. V.; Gibala, R. (Case Western Reserve Univ., Cleveland). Scr. Met., 3: 547-51(Aug. 1969).

The strength of high-purity Nb and Nb–O systems which exhibit alloy softening was investigated. The results indicate that impurity hardening is the dominant strengthening mechanism at low temperatures in virtually all bcc materials studied. Alloy softening appears to be an effect of non-random solute distribution. (J.R.D.)

43972 STUDIES OF THE TRUE HEAT CAPACITY OF RARE EARTH ELEMENTS AT LOW TEMPERATURES. IV. TRUE HEAT CAPACITY AT LOW TEMPERATURES, ENTHROPY, AND ENTHALPY OF La_2Te_3. Nogteva, V. V.; Paukov, I. E.; Yarembash, E. I. (Moscow Inst. of General and Inorganic Chemistry). Zh. Fiz. Khim., 43: 2118-20(Aug. 1969). (In Russian).

An adiabatic vacuum calorimeter was used for determining the heat capacity of La_2Te_3 in the temperature range 12.8 to 293°K. A structural transformation was observed at 204°K. The observed abnormalities are shown graphically and values of molar heat capacity, entropy, and enthalpy of La_2Te_3 are tabulated. (R.V.J.)

43973 BERYLLIUM: NEW CONSTRUCTION METAL. Izhvanov, L. A.; Mironov, N. F.; Kostogarov, S. B.; Bogorad, N. M.; Fraishtut, R. G.; Drozdov, B. G.; Pakhomov, Ya. D.; Gorokhov, V. A. Metalloved. Term. Obrab. Metal., No. 2, 24-8 (1969). (In Russian).

The principal mechanical and physical properties of beryllium are given, and data on the effects of grain size and oxidation on certain mechanical properties are discussed. Problems of preparing and refining metallic beryllium and beryllium compounds are analyzed. Methods for fabricating beryllium, such as extrusion, forging, rolling, and stamping, are described, and the properties of semi-fabricated beryllium are presented. (tr-auth)

43974 NEW MATERIALS AVAILABLE FOR FORGING. Coyne, J. E. Metal Form. Drop Forger., 36: No. 2, 53-6(Feb. 1969).

The composition and properties of some new complex forging alloys—mainly Ti-base alloys, Ni-base alloys, and steels, are outlined. The applications considered are principally aerospace, nuclear, and ordnance. (Metals Abstr.)

43975 FRACTURE MECHANICS TECHNOLOGY APPLIED TO HEAVY SECTION STEEL STRUCTURES. Wessel, E. T.; Clark, W. G. Jr.; Pryle, W. H. pp 825-50 of Proceedings of the 2nd International Conference on Fracture, Brighton, England, April 1969. Pratt, P. L. (ed.). London, Chapman and Hall, 1969. See CONF-690423.

A review is presented of a comprehensive program initiated to assess the applicability of existing linear-elastic fracture mechanics technology and testing techniques to low-to-intermediate strength structural steels that are employed in heavy sections in the electrical industry. The materials involved in the program include ASTM A216 Grade WCC and A533 Grade B Class I pressure vessel steels with minimum yield strength of the order of 40,000 and 50,000 psi, respectively, as well as ASTM A469 and A470 alloy steels with yield strength ranging from 75,000 to 150,000 psi. Plane-strain fracture toughness data were generated as a function of temperature for each of the alloys studied. Compact tension types of fracture toughness specimens ranging from 1 to 10 in. thick were involved in the program. Room temperature fatigue crack growth rate data expressed in terms of fracture mechanics parameters were also established for the A533B and A216C pressure vessel steels. The fracture toughness and fatigue crack growth rate data are used in an example problem to demonstrate the usefulness of the fracture mechanics approach to design. Although the entire program has not been completed, sufficient progress has been made to develop the conclusion that existing linear-elastic fracture mechanics technology is applicable to low-to-intermediate strength steels when used in sufficiently heavy sections to have plane-strain conditions. (auth) (UK)

43976 ASPECTS OF THE FAILURE OF LARGE STEEL PRESSURE VESSELS. Edmondson, B.; Formby, C. L.; Jurevics, R.; Stagg, M. S. (Central Electricity Generating Board, Berkeley, Eng.). pp 192-9 of Proceedings of the 2nd International Conference on Fracture, Brighton, England, April 1969. Pratt, P. L. (ed.). London, Chapman and Hall, 1969. See CONF-690423.

Work on the processes leading up to catastrophic failure of a pressurized structure is described. Measurements are given of crack opening displacements relevant to failures initiating from pre-existing defects. Particular attention is paid to the case of structures which have been loaded on previous occasions. This information is then related to data on strain ageing of cracked bars subjected to simulated operational cycles. The material properties important in high strain fatigue crack propagation were examined experimentally, and a correlation between propagation rates and measured crack tip strains is discussed. The final stage of failure of a structure, extension of a fast running crack beyond the immediate region where it initiates, is considered in terms of the fracture toughness at appropriate crack velocities. Measurements of this parameter involving destruction of large pressurized vessels are described. (auth) (UK)

43977 PROCEEDINGS OF THE 2nd INTERNATIONAL CONFERENCE ON FRACTURE, BRIGHTON, ENGLAND, APRIL 1969. Pratt, P. L. (ed.). London, Chapman and Hall, 1969. 958p. 240s. (CONF-690423).

Four papers were selected from those presented at the conference. A separate abstract was prepared for each. (J.R.D.)

For abstracts of individual papers see: 43951, 43952, 43975, and 43976.

43978 THE INFLUENCE OF VANADIUM ON THE SUSCEPTIBILITY OF WELD METAL TO HOT CRACKING. Leinachuk, E. I.; Parfesso, G. I. Avtomat. Svarka., No. 1, 14-17(Jan. 1969). (In Russian).

The investigations on the use of V for the prevention of hot cracking are reviewed. Further experiments were carried out in addition to methods previously described. Fusion was effected with 3.5 mm dia electrodes containing ferro-V, electrode graphite with AN-70 flux, and using dc welding with reversed polarity. Ten melts were made with 0.41 to 11.45% V, 0.28 to 0.33% C and 0.41 to 0.43% Mn. Cracking was assessed in percent and the results are illustrated. With increase of V the tendency to hot cracking decreases, then disappears and with a certain surplus V it reappears. V gives a finely dispersed structure, combines the C into carbides and has a strong influence on sulfide inclusions. It breaks up the continuity of sulfide defects, forms hard refractory carbo-sulfide and reduces the amount of sulfide inclusions in the form of flaws. If the C is combined in the form of finely dispersed uniformly distributed V carbides and the carbo-sulfide phase is distributed in the form of separate short chains or fine groups, then the tendency of the fused metal to hot cracking is low or cracking is absent. With a certain surplus V the carbides become brittle, group together, and the carbo-sulfide phase becomes noticeably brittle and the tendency to hot cracking increases. (Metals Abstr)

43979 THE INHIBITION OF NABARRO–HERRING CREEP BY SECOND-PHASE PARTICLES. Harris, J. E.; Jones, R. B.; Greenwood, G. W.; Ward, M. J. (Central Electricity Generating Board, Berkeley, Eng.). J. Aust. Inst. Metals, 14: 154-62(Aug. 1969).

High-temperature, low-stress creep data for magnesium and its alloys are summarized and new results presented. For pure magnesium and a solid solution alloy at stresses ≤100 psi, the dominant deformation mode is diffusion creep. With a two-phase alloy, diffusion creep, although inhibited, often makes an important contribution to the overall strain. However, with sintered products diffusion creep is almost completely suppressed. It is suggested that the presence of particles on grain boundaries parallel to the stress axis (either pre-existing or collected during the deformation) decreases the ability of these boundaries to act as sinks for vacancies and that this accounts for the observed inhibition of creep. Various possible mechanisms are discussed and evidence for particle/matrix interfaces acting as poor vacancy sinks in other physical processes is briefly reviewed. (Australia)

43980 REACTION OF SODIUM AND WATER IN TUBES. Dumm, K.; Mausbeck, H.; Schnitker, W. (Interatom, Bensberg, Ger.). Atomkernenergie, 14: 309-18(Sept.-Oct. 1969).

The reaction of sodium and water in tubes was investigated experimentally. A theoretical model of the reaction mechanism is given. The high-pressurized water enters a sodium filled tube and supported by reaction products, ejects the sodium into the pressure relief system. A zone of hydrogen is formed between sodium and water. It reduces the reaction rate after strong initial reactions. A thin layer of sodium remains on the tube wall and reacts with the water flowing into the tube. The function of a pressure relief system was tested as a model experimentally. (auth)

Structure and Phase Studies

Refer also to abstracts 43968, 44538, and 44555.

43981 (Y-1679) ROLLING AND RECRYSTALLIZATION OF BERYLLIUM SINGLE CRYSTALS. Hulsey, W. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 18, 1969. Contract W-7405-eng-26. 228p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The mechanisms of texture development and the relationships between deformation modes and recrystallization behavior in beryllium were investigated. Beryllium single crystals with six different initial orientations were rolled at 500°C. X-ray measurements of the deformation textures were correlated with polarized light measurements of metallographic samples to examine the deformation modes and identify the deformation features of the microstructures. The largest reorientation effects were produced by $\{10\bar{1}2\}$ twinning. This mechanism moved basal poles from the rolling direction and to a lesser extent from the transverse direction to the vicinity of the rolling plane normal. A relatively stable end orientation was found with basal poles forty degrees from the rolling plane normal toward the transverse direction. This is thought to result from duplex $\{10\bar{1}X\}\langle 11\bar{2}0\rangle$ slip, the $\{10\bar{1}X\}$ plane resulting from cross-slip between the (0002) and $\{10\bar{1}0\}$ planes. Two new microstructural effects were noted in crystals oriented for compression along the c axis. These were interpreted as two forms of deformation banding resulting from slip with a nonbasal Burgers vector. These bands played an important role in both the deformation and recrystallization behavior. Annealing the crystals at 700 and 800°C resulted in a recrystallization ranging from 0 to 53 per cent and 8 to 98 per cent, respectively. The stable end orientation as an initial orientation experienced the least recrystallization. Extensive twinning produced the largest per cent recrystallization. Recrystallization by subgrain growth and from "preformed nuclei" was observed. These preformed nuclei were primarily fragments of $\{10\bar{1}2\}$ twins. (auth)

43982 THE CRYSTAL STRUCTURES OF INTERMETALLIC COMPOUNDS OF NICKEL WITH THE RARE-EARTH METALS OR YTTRIUM. Lemaire, R.; Paccard, D. (CNRS, Grenoble, France). Bull. Soc. Fr. Miner. Crist., 92: 9-16(Jan.-Feb. 1969). (In French).

The crystallographic structures of intermetallic compounds belonging to the five series T_2Ni_{17}, TNi_5, T_2Ni_7, TNi_3, and TNi_2 where T is a rare earth metal or yttrium are discussed. It is shown that the TNi_5 crystal cell, but not that of TNi_2, plays a fundamental role in determining the structure of the other compounds. All the structures can be derived from one another by means of ordered substitutions of atoms in the TNi_5 cell. The type, the amount, and the order of these substitutions define the nature of the compound and its crystallographic structure. (auth)

43983 INFLUENCE OF STRESSES BUILT-UP ON COOLING ON MARTENSITIC TRANSFORMATION IN URANIUM. Drobnjak, Djordje V. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 5, 45-51(Sept. 1968).

The microstructural characteristics of martensitic alpha phase, which appears on beta → alpha phase change in high and commercial purity uranium and in uranium with a higher content of metallic impurities, have been studied. The results show that, besides the differences in transformation kinetics which are due to variations in the amount of metallic impurities and cooling rates, there are differences in both the transformation kinetics and the number of shear directions of martensitic products in different beta grains of the same material. These differences are generally attributed to the influence of internal stresses built-up on cooling. The crystallographic orientation of the beta grains is assumed to determine both the extent of stresses built-up on cooling and the transformation kinetics, and the temperature at which slip systems become active. In this connection, it is suggested that the number of slip systems involved in the stressing of each beta grain determines the number of shear directions on subsequent martensitic transformation. (auth)

43984 THE KINETICS OF TRANSFORMATION AND STRUCTURAL CHANGES IN ZIRCALOY-2 DURING CONTINUOUS COOLING. Drobnjak, Djordje. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 4, 35-43(Sept. 1968).

The effect of the cooling rate up to 500°C/sec on the temperature of transformation and on the structure obtained after cooling Zircaloy-2 to room temperature was investigated. A transformation diagram (continuous cooling diagram), consisting of two curves was constructed from the data obtained by thermal analysis. Within the upper curve region, the transformation proceeds by a proeutectoid reaction. The products of this reaction are grain boundary alpha alotriomorphs and Widmanstätten alpha plates. The lower curve consists of three segments in the region of the upper segment, i.e., at lower cooling rates, transformation proceeds by a eutectoid reaction which sets in immediately after the termination of the proeutectoid reaction. The structure consists of Widmanstätten alpha plates and an intermetallic precipitate mainly distributed between the plates. It was assumed that the transformation occurring within the middle segment, i.e., at intermediate cooling rates, is affected by a bainitic reaction, which starts only when additional undercooling has been applied after the completion of the proeutectoid reaction. However, products of this reaction do not differ from those of the eutectoid reaction; they are always mixed with the martensitic phase, which occurs in the form of fine preferentially oriented alpha plates clustered into colonies. The lower segment appears at constant temperature, and it is concluded to be the Ms temperature. Martensitic transformation is preceded by proeutectoid transformation. The transformation mechanisms within the region of the lower curve overlap in most cases, so that the eutecreaction may be replaced by the bainitic reaction, this one either by the eutectoid or by the martensitic reaction and, the martensitic by the bainitic reaction. (auth)

43985 THE EFFECT OF HEAT TREATMENT ON THE SIZE AND DISTRIBUTION OF PRECIPITATED SECONDARY PHASES IN DILUTE URANIUM ALLOYS. Jovanovic, Milan; Drobnjak, Djordje; Marjanovic, Milorad. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 3, 23-33(June 1968).

The effect of heat treatment on the size and distribution of precipitated secondary phases in five binary and multicomponent uranium alloys containing small contents of molybdenum, silicon, iron, and aluminum has been investigated by transmission electron microscopy. In the U–Si–Fe–Al and U–Mo–Si–Fe–Al alloys slowly cooled (3°C/min) from the gamma phase region there appears a dispersion of very fine particles (about 0.02 microns) arranged in parallel lines. In alloys oil-quenched from the gamma phase region and then annealed, fine particles do not lie in parallel lines. Particles are coarse and formed on sub-grain boundaries. It has been proved that the mechanism of beta-alpha phase transformation affects the distribution and density of the particles. (auth)

43986 GRAIN REFINEMENT AND THE KINETICS OF BETA–ALPHA TRANSFORMATION IN DILUTE URANIUM ALLOYS DURING CONTINUOUS COOLING. Drobnjak, Djordje; Jovanovic, Milan. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 1, 1-13(June 1968).

The effect of the cooling rate on alpha structure obtained by beta-alpha transformation in five binary and multicomponent uranium alloys with small contents of molybdenum, silicon, iron and aluminum was investigated and kinetics of transformation (KH) diagrams for three multicomponent alloys determined. The critical rates at which the mechanisms of transformation change were determined from the shape and size of the alpha grain and the discontinuity in the kinetics of transformation in the KH diagrams. It was found that the finest alpha structure is obtained at cooling rates at which transformation occurs at the beginning of the bainitic region. Depending on the composition of the alloy, the bainitic region overlaps, more or less, with the diffusion and martensitic regions. A higher degree of overlapping results in that even relatively minor changes in the cooling rate, within the range suitable for grain refinement, produce a considerable increase in grain size. In this case transformation proceeds partly in the diffusion or the martensitic region in which a considerably coarser structure is formed. Investigation results suggest that alloys whose bainitic regions are well separated from the diffusion and the martensitic regions are most suitable. In such alloys conditions are optimum for the occurrence of transformation in the bainitic region, without the participation of other mechanisms, in a broader interval of cooling rates. The change in grain size in the bainitic region can be negligible if this region is separated from the martensitic by a broader temperature range. (auth)

43987 STRESS RELAXATION IN BERYLLIUM BRONZES DURING A 70,000-HR TEST. Puchkov, B. I.; Rakhshtadt, A. G.; Rogel'berg, I. L. Prib. Sist. Upr., No. 10, 34(1968).

A study was made of stress relaxation in Br.B2, Br.B2.5 and Br.BNT-1.9 beryllium bronzes subjected to various heat treatments and subsequently tested for 70,000 hr. Specimens of the bronzes (rolled with 50% reduction into ribbons 0.30 mm thick) were water quenched from 780°C. One group of specimens was aged at 300°C for 4 hr, at 300°C for 3 hr, at 320°C for 2 hr, at 350°C for 1 hr or at 370°C for 20 min. Another group of specimens was rolled after quenching with a reduction of 30% and aged at 350°C for 1 hr. The results of the tests showed that the smallest decrease of stresses (0.9 to 3.32%) occurred in Br.BNT-1.9 bronze specimens in all various cases of heat treatment. It was also determined that the smallest decrease of stresses (0.9 to 1.42%) in all the bronzes was obtained in specimens which were water quenched from 780°C, cold rolled with 30% reduction, and aged at 350°C for 1 hr. (JPRS)

43988 COMMENTS ON SOLID SOLUTION SOFTENING IN B. C. C. ALLOYS. Roy, Ram B. (Aktiebolaget Atomenergi, Studsvik, Sweden). Scr. Met., 3: 531-6(Aug. 1969).

An analysis of softening mechanisms reveals that solution softening at lower temperatures and low concentrations occurs through the intervention of the alloy atoms on the thermally activated process controlling the low temperature deformation. This is achieved by decreasing the thermal fluctuation energy for the nucleation of double kink in Peierls process. At higher concentrations this is not possible. At higher temperatures (i.e., above the critical temperature T_c) where the controlling mechanism is not a thermally activated process, the normal behavior of solution strengthening is expected at all concentrations. (auth)

43989 STROENIE SPLAVOV TORIYA. (Constitution of Thorium Alloys). Badaeva, T. A. Moscow, Izdatel'stvo Nauka, 1968. 179p.

Data on the structure and physicochemical properties of binary and ternary thorium alloys are presented. Phase diagrams, the structure of solid solutions, and the physicochemical properties of these alloys are given. The published data on these materials are reviewed to 1967. The characteristics and properties of the binary phase diagrams which are related to the binary chemical nature of thorium are discussed. The properties of certain ternary thorium alloys are also described. An attempt was made to generalize the data concerning the structure of thorium alloys which enabled further study of the physicochemical properties of these alloys. (240 references). (tr-auth)

43990 VZAIMODEISTVIE TUGOPLAVKIKH METALLOV PEREKHODNYKH GRUPP S KISLORODOM. (Interaction Between Refractory Metals of Transition Groups and Oxygen). Kornilov, I. I.; Glazova, V. V. Moscow, Izdatel'stvo Nauka, 1967. 256p.

Important theoretical and practical relations concerning inorganic chemistry including the reactions of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, and W with oxygen, were examined. Data are given on the effects of oxygen on these metals at room and elevated temperatures and on the formation of nonstoichiometric suboxide compounds in the systems Ti–O, Zr–O, etc., during prolonged exposure to elevated temperatures. 537 references. (tr-auth)

43991 STRUCTURAL EFFECTS AND SURFACE EROSION IN METALS IRRADIATED WITH 10^{-8} SECOND LASER LIGHT PULSES. Akimov, A. I.; Mirkin, L. I. Fiz. Khim. Obrab. Mater., No. 2, 11-18(Mar.-Apr. 1969). (In Russian).

The effect of modulated laser light pulses 10^{-8} sec long on the structure and properties of 20 pure metals (W, Fe, Ag, etc.) and various types of steel was studied. The samples developed spots with rough, undulating surfaces, the amplitudes of the crests and troughs of these undulations increasing for metals with low mp. The density of the lattice defects introduced by the light pulses was greater than that arising from unmodulated light pulses of the same energy. The structural changes were apparently due to the heating of the metal by an expanding plasma and the undulating structure was due to the melting and motion of the metal under the influence of shock waves. (Metals Abstr.)

43992 EFFECT OF TITANIUM COATINGS ON THE TEMPERATURE OF THE BRITTLE TRANSFORMATION OF TUNGSTEN. Azhazha, V. M.; Amonenko, V. M.; Kovtun, G. P. Fiz. Khim. Obrab. Mater., No. 2, 138-9(Mar.-Apr. 1969). (In Russian).

The effect of thin Ti films (1 μm thick) on the temperature at which W transforms into the brittle state was studied. The presence of such surface films in the unannealed state appreciably reduces the temperature of the brittle transformation, e.g., from 190 to 160°C. After annealing, however, the presence of the Ti film may either raise or lower the transformation temperature, depending on the annealing temperature. Thus on annealing at 800°C the transformation rises from 190 to 230°C. (Metals Abstr.)

Radiation Effects

Refer also to abstract 45082.

43993 NEUTRON IRRADIATION EFFECT ON YIELD STRESS OF COPPER SOLID SOLUTION ALLOYS. Kruglov, A. S.; Bykov, V. N.; El-Shanshuri, I.; Gaber, Kh. At. Energ. (USSR), 26: 502-5 (June 1969). (In Russian).

Copper and binary copper alloys with Al, Si, Ni, Mg, Mn, Sn and Ge have been irradiated in a reactor. The 1-MeV neutron irradiation dose ranged from 1.2×10^{17} up to 5.2×10^{18} neutrons/cm^2. Within a certain interval of doses the yield stress increase due to irradiation (the radiation hardening) was found to be a linear function of a cube root of the neutron integral dose. An incubation period of the yield stress increase was observed for copper and all copper alloys as well. The rate of radiation hardening was small for the pure copper. For the alloys the rate of radiation hardening increased with an increase in content of alloying element. (auth)

43994 LENGTH CHANGE OF COPPER AND ALUMINUM AFTER ELECTRON IRRADIATION. Hanada, R.; Snead, C. L. Jr.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). J. Appl. Phys., 40: 3694-3702(Aug. 1969).

With the new application of capacitance-change techniques, length-change measurements were made in conjunction with annealing copper and aluminum specimens above their electron-irradiation temperature of about 15°K. Damage rates at this temperature were also measured. The Stage I recovery of length change is compared with its resistivity counterpart. Remarkable correspondence is obtained to the degree that percentages of recovery of individual substages compare favorably, with the same defect inferred to be responsible for recovery in both cases. The production rate for length change was determined to be $+1.8 \times 10^{-23}$ cm^2/electron for 2.2-MeV electrons. Linear bending with dose was observed. This bending was analyzed as due to electron straggling. The ratio of resistivity change to volume change and to stored energy for electron and heavy-particle bombardment shows good

relative agreement. From the results, it was concluded that these physical-property changes do not depend sensitively upon Frenkel pair close-pair separation. (auth)

43995 INTERPRETATION OF ELECTRON RADIATION DAMAGE IN F.C.C. METALS IN TERMS OF THE CONVERSION-TWO-INTERSTITIAL MODEL. Frank, W.; Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Radiat. Eff., 1: 117-31(Apr. 1969).

The theoretical interpretation of the radiation damage and its recovery in fcc metals is considered. The relative merits of the one-interstitial and the conversion-two-interstitial models are discussed. It is concluded that only the conversion-two-interstitial model is able to account for all aspects of the experimental data presented in the literature. Since electron irradiation is expected to generate relatively simple defect structures and since copper has so far been investigated in most detail, emphasis is put on electron radiation damage in copper: Recovery substage I_E is demonstrated to be due to the free migration of metastable interstitials diffusing randomly in one dimension (presumably crowdions). The evidence that stage III is due to the annihilation of freely migrating ⟨100⟩-dumbbell interstitials at vacancies is shown to be very strong. Whereas in typical resistivity recovery studied after low-temperature irradiation the stage-III interstitials are produced by athermal conversion of crowdions, the pinning of dislocations during a γ-irradiation above room temperature reveals the thermal conversion of crowdions. The activation energy for thermal conversion is estimated to lie between 0.30 eV and 0.38 eV. Apart from individual features, the radiation damage in the other fcc metals fits well into the pattern given for copper. A noteworthy peculiarity is that in the recovery of gold and (hcp) cadmium free migration of a defect at low-temperatures could not be observed. In terms of the conversion-two-interstitial model this has the simple explanation that in these metals the activation energy for thermal conversion of the low-temperature interstitial is smaller than its migration energy. (auth)

43996 RELATION BETWEEN THE DISLOCATION DENSITY AND RESISTIVITY INCREMENT DURING LOW TEMPERATURE IRRADIATION OF FCC METALS. Jackson, J. J. (Argonne National Lab., Ill.); Herschbach, K. Radiat. Eff., 1: 101-8(Apr. 1969).

It is shown that the ratio of the resistivity increments injected by irradiation at low temperature into deformed and into annealed specimens is related to the difference in fractional recovery that occurs in Stage I between the two specimens. Using this relation the ratio of resistivity increments to the resistivity increment due to dislocations is computed for a number of different irradiations. For a given metal and type of irradiation the enhancement of resistivity increment in a deformed specimen is closely proportional to its dislocation resistivity. It is shown that this is more in accord with explanations of the enhancement based on greater defect production per unit irradiation dose than with explanations based on greater specific resistivity of Frenkel pairs in the presence of large defect concentrations. (auth)

43997 RADIATION DAMAGE PRODUCED IN COPPER BY COPPER ION IRRADIATION. Wilson, M. M. (Oxford Univ.). Radiat. Eff., 1: 207-8(July 1969).

Specimens of single-crystal copper were irradiated at 25°C using copper ions at 30 keV. It was found that under conditions of little cascade overlap the radiation damage produced consists largely of vacancy-type Frank sessile loops with loop normals ⟨111⟩ and Burgers vectors of the type (a/3) ⟨111⟩. (J.R.D.)

43998 OBSERVATION OF ELECTRON IRRADIATION DAMAGE PRODUCED AT LOW TEMPERATURE IN A HIGH VOLTAGE ELECTRON MICROSCOPE. Goringe, M. J. (Oxford Univ.); Valdre, U. Radiat. Eff., 1: 133-5(Apr. 1969).

A review of damage observations is presented. It is noted that visible signs of damage have been observed at room temperature i.e., interactions within dislocations. Irradiation at 30 to 40°K results in greatly increased damage rates and no marked annealing of this damage has so far been detected. More quantitative experiments are in progress to determine the values of the various parameters. (J.R.D.)

43999 NEUTRON RADIATION HARDENING OF POLYCRYSTALLINE IRON. Seidel, G. P. (National Bureau of Standards, Washington, D. C.). Radiat. Eff., 1: 177-90(July 1969).

The dependence of the yield stress of vacuum-annealed and hydrogen-purified ion polycrystals on neutron dose and annealing temperature and the influence of these two parameters on the effect of static strain-aging has been investigated. The radiation hardening was found to depend sensitively on the interstitial impurities N and C. This may be explained by both a nucleation of precipitation and a trapping of the impurities at radiation produced intrinsic defects. The radiation enhanced precipitation predominates in the relatively impure iron samples at low doses and may be eliminated by annealing at 190°C. The trapping becomes effective at higher doses or in higher purity iron. Below 400°C two recovery stages for the yield stress are observed, one between 200 and 260°C and the other between 320 and 400°C; these may be explained by the detrapping of N and C respectively. The static strain-aging was found to be reduced by neutron irradiation. It reappears after annealing at temperatures at which the precipitates are thought to be redissolved and the C and N atoms to be detrapped. (auth)

Ceramics and Cermets

Refer also to abstracts 43291, 43455, and 43938–43941.

44000 VIBRATORY COMPACTION. III. RATE OF ENTRY. Ayer, J. E.; Soppet, F. E. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 52: 414-16(Aug. 21, 1969).

A study of the rates at which fine particles can be vibratorily infiltrated into a column matrix of packed coarser particles is reported. Infiltration and compaction rates of angular tetrahedra, rounded tetrahedra, and spheres were compared. The dependence of infiltration rate on ratio of the sizes of matrix to infiltrating particles and the interparticle void fraction in the matrix were found. The influence of acceleration and frequency of vibration on infiltration rate was also determined. (auth)

Corrosion and Erosion

Refer also to abstract 43942.

44001 EFFECT OF HUMIDITY ON THE SURFACE OXIDATION OF UC SINGLE CRYSTALS AT ROOM TEMPERATURE. Matzke, Hj. (CCR-EURATOM, Ispra, Italy). J. Appl. Phys., 40: 3819-24(Aug. 1969).

The formation of oxide layers on fresh {100} cleavage faces of uranium monocarbide (UC) single crystals during exposure to air at room temperature is studied using the channeling technique and Rutherford backscattering of 1-MeV He^+ ions. The thickness of the layers increases with humidity and, for exposure times of about 1 week, ranges between 20 and 80 Å. (auth)

44002 STEAM OXIDATION KINETICS AND OXYGEN DIFFUSION IN UO_2 AT HIGH TEMPERATURES. Bittel, J. T.; Sjodahl, L. H.; White, J. F. (General Electric Co., Cincinnati). J. Amer. Ceram. Soc., 52: 446-51(Aug. 21, 1969).

Results of steam oxidation measurements of UO_2 cylinders from 885 to 1835°C may be expressed by the equations: $K_p = 2.44 \times 10^5 \exp(-52{,}100 \pm 2800)/(RT)$ $mg^2/cm^4 \cdot s$ for the parabolic rate of oxidation and $D_c = 99 \exp(-56{,}900 \pm 1800)/(RT)$ cm^2/s for the chemical oxygen diffusion coefficient. K_p and D_c, obtained from thermobalance measurements to 1500°C and from pre- and post-test weights for the higher temperatures, were independent of sample weight from 10 to 149 g and of surface-to-volume ratios from 2.34 to 18.74 cm^{-1}. D_c varied as the 0.65 power of the final average excess oxygen (x in UO_{2+x}). The oxidation was accompanied by considerable grain growth. A bulk diffusion mechanism was verified by analyses of partially oxidized samples using both x-ray diffraction and analytical chemistry; an oxygen gradient was demonstrated by each technique. (auth)

Preparation and Fabrication

Refer also to abstracts 43385, 43447, 43955, 44773, 45082, and 45145.

44003 (BNWL-1014) COLD PRESSING OF ALUMINUM–RARE EARTH OXIDE COMPOSITES. Fullam, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1969. Contract AT(45-1)-1830. 26p. Dep. CFSTI.

Results of a brief study of cold pressing oxide-aluminum composites are summarized. The study originated because of a need to fabricate aluminum–Pm_2O_3 targets for the ^{146}Pm burnout program and was extended to a more general study because of the apparent advantages of the procedure. Rare earth oxide-aluminum composites can be readily compacted into mechanically stable adherent pellets by cold pressing techniques. The densities obtained are dependent on the applied pressure, length-to-diameter ratio of the pellet, and composition of the composite. If oxide density is not a controlling factor, then cold pressing of aluminum

composites has many attractive features to recommend it and should be considered as a potential method for fabricating Pm_2O_3 into useful shapes. (auth)

44004 (INR–1028) STUDIES ON SOME PROPERTIES OF PLASMA SPRAY POWDERS. Derko, H.; Laskowski, M. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 27p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Investigations are described on diverse parameters relative to imported spray powders which are designed to be used for Plasma Flame spray process. The measurements are carried out using standard methods. The results obtained are the basis of information to facilitate estimation of the suitability of powders for Plasma Flame Spray process. (auth)

44005 PHENOMENOLOGY OF GRAIN GROWTH AND POROSITY CHANGES DURING SINTERING OF UO_2. Kostic, E.; Petrovic, V. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 6, 53–62(Nov. 1968).

Aspects of observed microstructural changes during densification on sintering UO_2 powder in hydrogen, helium, and in vacuum at 1300 to 1550°C from 0 to 8 hours are discussed. (auth)

44006 VIBRATORY COMPACTING OF SPHERICAL UO_2 PARTICLES INTO VARIOUS FUEL ELEMENT GEOMETRIES. PART I. A CONTRIBUTION TO THE THEORY OF VIBRATORY COMPACTING. Vogt, Jan (Aktiebolaget Atomenergi, Stockholm); Zivanovic, Branislav. Bull. Boris Kidric Inst. Nucl. Sci., 19: Ceram. Met., No. 2, 15–22(June 1968).

The packing of spherical particles in tubular and annular fuel elements was studied theoretically. In the case of the tubular element it was found that besides the known ratio between the first fraction (r_1) and the second fraction (r_2) diameters, $r_1/r_2 \approx 7$, there also exist geometrical conditions for packing spheres satisfying the diameter ratio $3 < r_1/r_2 < 4$. For the annular type, the packing density for monodispersed spherical particles were theoretically calculated, as a function of the fuel element geometry, the number of spheres per layer and the ratio between the inner and outer element diameters. The theoretical relations were experimentally proved using dense UO_2 spheres. (auth)

44007 ALPHA AUTORADIOGRAPHY OF $(U,Pu)O_2$ MICROSPHERES. Kerr, J. M.; Carlson, R. V.; Shield, W. A. (Babcock and Wilcox Co., Lynchburg, Va.). Contract AT(30-1)-3714. J. Amer. Ceram. Soc., 52: 461–2(Aug. 21, 1969).

Alpha autoradiography techniques were developed to examine UO_2–PuO_2 microspheres for Pu distribution. The method was used to study variables in the gel-addition process such as length of exposure of the microspheres to aqueous plutonium nitrate, temperature, acidity, and Pu concentration in the solution. It is noted that alpha autoradiography was useful in determining that Pu(III) is the optimum oxidation state for sorption and uniform distribution of Pu in spherical urania gel particles. (J.R.D.)

44008 ELECTRODEPOSITION OF TITANIUM DIBORIDE COATINGS. Schlain, David; McCawley, Frank X.; Wyche, Charlie (College Park Metallurgy Research Center, Md.). J. Electrochem. Soc., 116: 1227–8(Sept. 1969).

Adherent, smooth coatings of TiB_2, metallic in appearance and 3 to 6 mils in thickness, were electrodeposited on Inconel from a molten salt electrolyte at 900°C. The electrolytic cell was operated under an argon atmosphere at cathode and anode current densities of approximately 0.4 A/in.^{2} (6.2 A/dm^2). The coating was formed at the rate of about 1 mil/hr. The deposits were identified as TiB_2 by x-ray diffraction. (P.C.H.)

44009 METHOD OF COATING URANIUM CARBIDE WITH NIOBIUM AND NUCLEAR FUEL ELEMENTS OBTAINED ACCORDING TO SAID METHOD. Theisen, R. (to EURATOM). Canadian Patent 813,998. May 27, 1969. Priority date Jan. 24, 1962, Germany.

The process consists of subjecting the UC surfaces to a cleaning step by ion discharge in a vacuum and then vaporizing an intermediate binding layer of copper followed by vapor-depositing Nb metal by electron bombardment with all steps being sequentially performed within the evacuated enclosure. The presence of impurities in the final coating is prevented by interposing a movable screen just before the final step. The screen traps impurities which may be present in the hot Nb. The Nb-coated surface within the enclosure is maintained at 400 to 650°C for at least two hours. Thickness of the Nb coating is between 0.1 and 30 microns. (F.S.A.)

44010 A STUDY OF THE SINTERING OF BORON NITRIDE POWDER DURING HOT PRESSING. Kuznetsova, I. G.; Poluboyarinov, D. N. Tr. Mosk. Khim.-Technol. Inst., No. 50, 205–9 (1966). (In Russian).

Sintering of boron nitride powder during hot pressing was investigated. Different types of boron nitride were used, the experiments were carried out at different firing temperatures. It was found that pure, ground powder of crystalline boron nitride obtained by nitration at high temperatures does not sinter during hot pressing, even at pressures of 300 kg/cm^2 and at temperatures up to 2000°C. The powder of boron nitride synthesized at low temperatures differs markedly in structure, form, and particle size from high-temperature material. Low-temperature boron nitride is highly disperse: crystal size of 0.06 to 0.2 μ, specific surface area of 100 to 120 m^2/g. The highly disperse character and imperfect crystal structure of this type of boron nitride is due to recrystallization and sintering at high temperatures. Specimens obtained from hot pressing of low-temperature boron nitride exhibit increase in crystal size (up to 60 to 80 μ) during sintering. They have high density (approximate porosity of 0.0 to 0.1%) and appreciable strength (crushing strength of 3500 kg/cm^2 at room temperature). (JPRS)

Properties Evaluations

Refer also to abstract 45053.

44011 THERMAL DIFFUSIVITY MEASUREMENT OF HYPOSTOICHIOMETRIC UO_2 BY AN ELECTRON BEAM TECHNIQUE. Serizawa, Michiya (Hitachi Ltd., Kawasaki, Japan); Kaneko, Hiromitsu; Koizumi, Masumichi. J. Nucl. Sci. Technol. (Tokyo), 6: 419–23(Aug. 1969).

Thermal diffusivities of $UO_{2.00}$, $UO_{1.99}$, and $UO_{1.95}$, were measured. Thermal conductivities of them were calculated from the thermal diffusivity data and specific heats. Thermal diffusivities and thermal conductivities of $UO_{1.99}$ and $UO_{1.95}$ were not different from each other within the experimental errors and lower than those of $UO_{2.00}$ at 1,000 to 1,600°C. An increase of thermal conductivity of $UO_{1.95}$ was found above 1,600°C. (auth)

44012 ACTIVATION ENERGY IN SINTERING. Morgan, C. S. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 52: 453–4(Aug. 21, 1969).

The effects of varying the initial heating conditions on the activation energy for sintering are discussed. An evaluation of temperature profiles using a computer was made on ThO_2. While the experimental measurements are not sufficiently precise to make exact values of activation known, they demonstrate that the activation energy in initial sintering may be entirely incompatible with a diffusion-controlled process. (J.R.D.)

44013 OXYGEN DIFFUSION IN Gd_2O_3. Wirkus, C. D.; Berard, M. F.; Wilder, D. R. (Ames Lab., Iowa). J. Amer. Ceram. Soc., 52: 456(Aug. 21, 1969).

Oxygen diffusion in monoclinic-type B-form Gd_2O_3 was measured. Data are included as plots on diffusion products for Gd_2O_3 fitted to an Arrhenius equation and a plot showing oxygen self-diffusion in Gd_2O_3 as function of temperature. (J.R.D.)

44014 ELASTIC PROPERTIES OF POLYCRYSTALLINE YTTRIUM OXIDE, DYSPROSIUM OXIDE, HOLMIUM OXIDE, AND ERBIUM OXIDE: ROOM TEMPERATURE MEASUREMENTS. Manning, W. R.; Hunter, O. Jr.; Powell, B. R. Jr. (Ames Lab., Iowa). J. Amer. Ceram. Soc., 52: 436–42(Aug. 21, 1969).

The Young's and shear moduli of polycrystalline yttrium oxide, dysprosium oxide, holmium oxide, and erbium oxide were determined at room temperature as a function of volume fraction porosity using the sonic resonance technique. Linear relations empirically described the data for Y_2O_3, Ho_2O_3, and Er_2O_3. The Young's and shear moduli data for Dy_2O_3 were empirically described by Hasselman's and Spriggs' equations, respectively. The empirical curves which best fit the data were compared to theoretical expressions and agreed closely with a modified form of Mackenzie's equation. Values for bulk modulus, Poisson's ratio, and the Debye temperature were computed for each oxide, and the bulk modulus-volume relation was determined and compared with that of other oxides. (auth)

44015 STUDY OF THE IMPACT STRENGTH OF CERMETS IN THE SYSTEM Al_2O_3–METAL. Skidan, B. S.; Vlasov, A. S.; Poluboyarinov, D. N. Tr. Mosk. Khim.-Technol. Inst., No. 50, 213–15(1966). (In Russian).

The impact strength of cermets in the system Al_2O_3 – Me has been studied, where Me represents W, Mo, Nb, Cr, Ni, and Fe. Means of increasing this impact strength have been investigated. Specimens 3.7 × 3.7 × 35 mm were sintered in a TVV-4 vacuum kiln at temperatures near the melting point of the readily fusible component of the cermet. It was found that the impact strength of these investigated cermets increases with increase in content

of the metallic phase and also with diminution in porosity. It is also increased appreciably by adding material that forms an intermediate layer, as observed by introduction of Zr into W + Al_2O_3 cermet. (JPRS)

44016 VAPORIZATION AND CREEP OF SINTERED OXIDE CERAMICS. Bakunov, V. S.; Lukin, E. S.; Poluboyarinov, D. N. Tr. Mosk. Khim.-Technol. Inst., No. 50, 216-20(1966). (In Russian).

Interest in pure oxide ceramics is due to the use of these materials for construction units operating under load in a vacuum or in various gases in the range 1500 to 2500°C. Vaporization and creep of these ceramics at temperatures up to 2000 to 2500°C are discussed. Creep rate was measured for Al_2O_3, BeO, MgO, ZrO_2, $MgO \cdot Al_2O_3$, and $3Al_2O_3 \cdot 2SiO_2$. The activation energy of creep and the heat of vaporization were computed and tabulated for these oxides, and empirical relations were established between temperature and the rates of vaporization and creep. The sum of the heat of vaporization and the activation energy of creep proved to remain approximately the same for all investigated materials: 210 to 230 kcal/mol (the oxides arrange themselves in a series—Al_2O_3, ZrO_2, $MgO \cdot Al_2O_3$, $3Al_2O_3 \cdot 2SiO_2$, MgO, and BeO, the activation energy of creep declining from the first to the last, from 197 to 57 kcal/mol, the heat of vaporization increasing, from 33 to 172 kcal/mol). It is assumed that the sum of these two factors represents the averaged energy of formation and displacement of the structurally weakened elements in the lattice. (JPRS)

44017 POROSITY DEPENDENCE OF THE ELASTICITY MODULUS OF TaB. Claussen, N. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Mater. Sci. Eng., 4: 245-6(July 1969). (In German).

The elastic modulus of TaB was measured as a function of the porosity using the resonance frequency method. The elastic modulus was calculated from the resonance frequencies of the longitudinal and both transverse oscillations so that it could be shown that the samples had a homogeneous structure without compression texture. The measurement values were expressed by a linear regression on the logarithmic equation $E = 71000\ e^{-3.55P}$ kp/mm$_2$, where E is the elastic modulus in dependence on the porosity P. (J.S.R.)

Structure and Phase Studies

Refer also to abstracts 44005 and 44549.

44018 EXISTENCE AND STRUCTURE OF A NEW COMPOUND M_7O_{12} IN THE SYSTEMS ZIRCONIUM OXIDE–MAGNESIUM OXIDE AND HAFNIUM OXIDE–MAGNESIUM OXIDE. Delamarre, Claude (CECM, Val-de-Marne, France). Compt. Rend., Ser. C, 269: 113-15(July 16, 1969). (In French).

Evidence was found for the formation of the compound $Mg_3Zr_5O_{12}$ in the system $MgO-ZrO_2$. The structural parameters are a = 6.178 A and $\alpha = 99°35'$. A composition with the same formula and structure was found for the $MgO-Hf_2$ system. The compound is not stable at low temperature in the immediate vicinity of fusion. It also decomposes during the course of cooling. (P.C.H.)

44019 ALLOYS OF THE ZIRCONIUM–NICKEL–BORON SYSTEM. Voroshylov, Yu. V.; Kuz'ma, Yu. B. Visn. L'viv. Derzh. Univ., Ser. Khim., No. 9, 17-20(1967).

Alloys of the Zr–Ni–B system were studied by the method of x-ray structural analysis and the isothermal section at 850°C constructed. The ternary compound $Zr_2Ni_{21}B_6$ (τ-phase) was found with a homogeneity region of 5 to 16 at. % Zr and 20 at. % B, which has a structure of the $W_2Cr_{21}B_6$ type with a lattice constant varying from 10.599 to 10.667 Å upon an increase of Zr. The τ-phase is in equilibrium with the Ni-base solid solution and with the compounds Ni_2B, Ni_3B, $ZrNi_5$, Zr_2Ni_7, Zr_2Ni_5, and ZrB_2. (JPRS)

44020 PHASE RELATIONS IN THE SYSTEM $CaO-Ta_2O_5-SiO_2$. Reeve, D. A.; Bright, Norman F. H. (Dept. of Energy, Mines, and Resources, Ottawa). J. Amer. Ceram. Soc., 52: 405-9 (Aug. 21, 1969).

The system $CaO-Ta_2O_5-SiO_2$ was studied using a combination of hot-stage microscopy and the quenching technique. Primary crystallization fields were defined for the various calcium silicates and for the calcium tantalates: $CaO \cdot 2Ta_2O_5$, $CaO \cdot Ta_2O_5$, $2CaO \cdot Ta_2O_5$, and $4CaO \cdot Ta_2O_5$. A congruently melting ternary compound $10CaO \cdot Ta_2O_5 \cdot 6SiO_2$, isostructural with the mineral niocalite, is the only ternary phase in the system. A large two-liquid region extends across the system from the $CaO-SiO_2$ binary to within 1 wt % of the $Ta_2O_5-SiO_2$ binary but does not cut it, in marked contrast to the analogous $CaO-Nb_2O_5-SiO_2$ system. Other somewhat unexpected differences were noted between these systems. (auth)

44021 CRYSTALLOGRAPHIC DATA ON THE B SESQUIOXIDES La_2O_3 AND Pr_2O_3. Willer, Bernard; Daire, Marc (Faculte des Sciences, Strasbourg). Bull. Soc. Fr. Miner. Crist., 92: 33-7(Jan.-Feb. 1969). (In French).

The lattice parameters of the rare earth sesquioxides La_2O_3 and Pr_2O_3 with B-type monoclinic structure were determined by a variant of Ito's method. Some details about the method used are included. The calculated cell volumes, as a function of atomic number, are in good agreement with those of the known monoclinic rare earth sesquioxydes. (auth)

44022 PHASE DIAGRAMS FOR CERAMISTS: 1969 SUPPLEMENT. Levin, Ernest M.; Robbins, Carl R.; McMurdie, Howard F. Columbus, Ohio, American Ceramic Society, 1969. 625p. $30.00.

The 2083 phase diagrams included are of salts, oxides, and sulfide systems, 70% of which have been published since 1960. Special effort has been made to complete the coverage of salt systems and to include hydrothermal and pressure diagrams. The systems given include metal–oxygen systems, including those containing valence changes; metal oxide systems; systems with oxygen–containing radicals; systems containing halides only; systems containing halides with other substances; systems containing cyanides, sulfides, sulfides with oxides, metal with oxygen and sulfur, and combinations of these; and systems containing water. (J.C.W.)

44023 PHASE TRANSFORMATIONS OF BORON ON DISSOLUTION OF BERYLLIUM IN IT. Vekshina, N. V.; Markovskii, L. Ya.; Kondrashev, Yu. D.; Stroganova, I. M. Zh. Prikl. Khim., 42: 1229-34(June 1969). (In Russian).

Chemical and roentgenographic investigations of the B–Be system showed a significant solubility of beryllium in the lattice of the beta-rhombohedral modification of boron. The dissolved beryllium promotes different phase modifications at various temperatures. (M.C.G.)

Radiation Effects

Refer also to abstracts 43648, 45052, 45082, and 45083.

44024 (WCAP-3850-4) POST-IRRADIATION EXAMINATION OF CVTR FUEL ASSEMBLIES. Final Report. Balfour, M. G.; Mellor, J. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Aug. 1969. Contract AT(30-1)-3850. 208p. Dep. CFSTI.

A program of post-irradiation examinations was conducted upon failed CVTR standard core and experimental fuel rods to determine the nature and the causes of the defects. The examinations showed a single rod failure in each of two standard assemblies and in three of four special high power test assemblies. The failures generally are characterized by multiple clad defects, with localized internal hydriding, but no correlation was found in terms of design or irradiation performance to account for them. The evidence suggests that the failures were caused by local hydriding and consequent embrittlement of the Zircaloy clad combined with clad stresses. The source of internal hydriding is related to the fabrication history peculiar to each rod. (auth)

Plastics and Other Materials

Refer also to abstracts 43327, 43482, and 43941.

44025 (N-69-23865) IN SITU ELECTRON, PROTON, AND ULTRAVIOLET RADIATION EFFECTS ON THERMAL CONTROL COATINGS. Final Report, September 1, 1965–July 15, 1968. Fogdall, Lawrence B.; Cannaday, Sheridan S.; Brown, Richard R. (Boeing Co., Seattle, Wash. Aerospace Group). July 1968. Contract NAS5-9650. 149p. (NASA-CR-100146). CFSTI.

Measurements of spectral reflectance in the wavelength region from 240 to 2500 millimicrons were obtained in situ on a total of about 200 samples, before exposures began, periodically during exposures, and both in vacuum and in air, following exposures. Data obtained from these measurements were analyzed for spectral reflectance changes, for solar absorptance changes, for irradiation rate effects, and for synergistic effects. The specular surfaces tested and the leafing aluminum–silicone coating tested are relatively hard to reflectance degradation under 50-keV electron exposure. Except leafing aluminum, the diffuse coatings or paints tested were subject to severe, in-air recoverable degradation in the infrared wavelength region, and to substantial visible-region reflectance losses, which are less recoverable or bleachable on reexposure of test samples to air. Coatings employing methyl silicone binders sustain the greatest degree of reflectance degradation in the infrared wavelength region. (auth) (STAR)

44026 EFFECT OF RADIATION ON THE ADHESIVE PROPERTIES OF EPOXY–METAL AND EPOXY–GLASS ADHINTS. Tilmans, Anthony Lynn. Pittsburgh, Carnegie-Mellon Univ., 1968. 109p. Thesis.

Because of a lack of sufficient knowledge about the effects of radiation on adhesives, several important radiation facilities have been plagued by unexpected shutdowns that are costly in time as well as money. Many of the shutdowns can be attributed to the deterioration of epoxy adhesives which are subjected to radiation exposure. One type of an epoxy system, consisting of Epon 828, was chosen to determine what effect that radiation had on a selected adhesive and the mechanical properties of the adhesives and of the adhesive joint. From this data it was hoped that shutdowns could be anticipated and appropriate plans could be made for periodic inspection of various radiation facilities. It was also thought that information of this type could also be useful in the design of the next generation synchrotron which is soon to be constructed. In adhesion-radiation studies the most important unresolved question is whether the failure occurs between the adhesive and the adherend (adhesive or interface failure) or if the failure occurs within one of the components (cohesive failure). The method used to determine whether there is a cohesive or adhesive failure involved bulk tests at different radiation levels. By testing two component shear specimens at similar radiation levels, a comparison was made to determine if the failure was in the adhesive or at the interface. Because the space available for radiating samples was very limited, smaller than standard size samples were chosen to allow for a statistical analysis of the data. Besides the usual types of samples to be tested, i.e., tension and compression, which would give the effects of radiation on the physical properties of the material, other samples had to be designed to give bond strength values. Using the theory of tubular joints, a disk type of sample was chosen for the bond strength study. A punch and die fixture, patterned after the tubular geometry, was decided upon as the testing apparatus. Punches and dies of varying diameters were tested to determine optimum sample thickness and amount of clearance between the punch and die. Preliminary tests were performed on the epoxy system to determine the criteria to be used throughout the study and to avoid any difficulty that might arise at a later time. These tests included cure cycle, exothermic reaction temperature, dose rate of radiation, environment during radiation, tension test procedure, and absorbed radiation in the sample. A photographic strain technique was used as a new tension test procedure developed to work with "minisamples" for radiation testing. The compressive shear strength of this epoxy system benefited slightly from the additional crosslinking caused by low orders of irradiation, but eventually began to degrade after two thousand megarads. The principal effect noticed in inspecting the samples was an increase in hardness due to high (five thousand megarads) amounts of radiation. The effects of radiation on the two component samples resulted in the following conclusions: radiation had little effect on the interface bonding characteristics for all the samples of low bond strength; radiation affected those two component samples that exhibited a bond strength approximating the bulk material shear strength similarly to those of the bulk material; the surface treatments and finishes of adherends were a more important factor in the bond strength than were the different adherends for this particular adhesive; and the bond strength of the epoxy-glass samples was stronger than the tensile strength of the particular glass adherend used in the study. (Diss. Abstr.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

44027 ANNUAL REVIEW OF ASTRONOMY AND ASTROPHYSICS. VOLUME 7. Goldberg, Leo; Layzer, David; Phillips, John G. (eds.). Palo Alto, Calif., Annual Reviews, Inc., 1969. 725p. $8.50; Foreign $9.00.

A series of critical reviews covering research in a number of important fields of astronomy and astrophysics is presented. Separate abstracts were prepared for 15 of the 19 reviews. (W.D.M.)

For abstracts of individual papers see: 44028, 44033, 44036–44039, 44075–44077, 44105, 44106, 44126, 44143, 44146, and 44200.

44028 DEVELOPMENTS IN THE THEORY OF SYNCHROTRON RADIATION AND ITS REABSORPTION. Ginzburg, V. L.; Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Annu. Rev. Astron. Astrophys., 7: 375-420(1969).

In 1965 the authors reviewed the theory of synchrotron radiation. A new review was felt justified for three reasons: First, errors were discovered in the theory of noncircular particle motion. Second, important developments have been made in the theory of reabsorption of synchrotron radiation. Third, it has become necessary to consider the synchrotron radiation and its reabsorption for a rapidly moving cloud of relativistic particles. 43 references. (W.D.M.)

Cosmic Ray Exposure Ages

44029 PRODUCTION OF ^{22}Na AND ^{3}H IN A THICK SILICATE TARGET AND ITS APPLICATION TO METEORITES. Trivedi, B. M. P.; Goel, P. S. (Indian Inst. of Tech., Kanpur). J. Geophys. Res., 74: 3909-17(July 15, 1969).

A number of glass plates chosen from a stack of thick target having the gross chemical composition of stone meteorites, and exposed to 3-GeV protons, were analyzed for ^{22}Na and ^{3}H. ^{22}Na was measured by the nondestructive $\gamma-\gamma$ coincidence counting, and ^{3}H was measured in gas phase after chemical processing. Complete distributions of these nuclides in the thick-target assembly were mapped. Effective cross sections for ^{3}H and ^{22}Na production were calculated on the oxygen and the silicon target basis, respectively. The cross sections show significant buildup factors along the depth followed by an exponential decrease. The distribution of ^{3}H, in both the radial and lateral directions, is comparatively steeper. The results are compared with similar published studies on iron targets. The data are used to calculate ^{3}H and ^{22}Na production rates in spherical chondrites exposed to cosmic radiation, assuming that only primary nucleons of energy greater that 1.2 GeV are effective in the nuclide production, and that these can be represented by an average energy of 3 GeV. The calculated production rates of ^{3}H (450 to 670 atom min^{-1} kg^{-1}) and ^{22}Na (80 to 110 atom min^{-1} kg^{-1}) are comparable to the observed range of concentrations of these nuclides in stone meteorites.(auth)

Stars

Refer also to abstract 44711.

44030 (AD-682195) TABLES OF IONIZATION EQUILIBRIUM EQUATION OF STATE AT STELLAR TEMPERATURES AND DENSITIES. Rouse, Carl A. (Naval Research Lab., Washington, D. C.). Nov. 22, 1968. 77p. (NRL-6756). CFSTI.

The screened Coulomb formulation of the ionization equilibrium equation of state is used to generate data for equation of state tables for a stellar mixture of eight elements. Two temperature–density T-rho regions are used: the T-rho region of the photosphere and low chromosphere of the Sun and the T-rho region of the interior of normal stars. Information useful for detailed opacity calculations is also included. The basic ideas and formulas used are outlined. (USGRDR)

44031 (PPL-Trans-1) SOLUTION OF THE PROBLEM OF STABILITY OF A STELLAR SYSTEM WITH THE EMDEN DENSITY LAW AND SPHERICAL VELOCITY DISTRIBUTION. Antonov, V. A. Translated for Princeton Univ., N. J., from Vestn. Leningrad. Univ., No. 7, Ser. Mat., Mekh. Astron., No. 2, 135-46 (1962). 34p. Dep. CFSTI.

Applying a criterion previously derived by the author, the stability of stellar systems with spherical velocity distribution and Emden's polytropic density law is demonstrated for the exponent $n \geq 3/2$. (auth)

44032 STELLAR COMPOSITION OF HALO-TYPE GLOBULAR CLUSTERS. Talbert, Freddie Deward. Austin, Tex., Univ. of Texas, 1968. 145p.

Thesis.

Low-dispersion photoelectric spectral scans of a selection of stars with low abundances of metals coupled with similar data for four halo-type globular clusters (M 3, M 5, M 13, M 92) are used to estimate the stellar content of these clusters. The wavelength range of the measurements is 3350 to 6100 Å; spectral purity of the observations is 40 to 60 Å. Cross-correlation of the instrumental profiles (cluster or stellar) provides a simple method of data smoothing and also aids in the determination of spectral features present in the scans. Interstellar absorbing matter presents a problem in making such composition estimates; therefore, two cases are considered for each cluster: (1) the reddened cluster (i.e., the observed cluster) and (2) the unreddened cluster (for which the observed energy distribution has been corrected for estimates of interstellar reddening based on the absorption model of Sharov). Equations of the form developed by Tull, which are independent of the distance to the cluster, set up for the stellar and cluster energy distributions described by ten measurements at the wavelengths suggested by Code and three equivalent width parameters (the MgH-Mg I triplet complex at ~5120 Å, the G-band at ~4300 Å, and the CN–Mg I complex at ~3840 Å) allow one to estimate the stellar composition of the clusters. The method of solution is a least-square differential correction scheme. Several models were developed for each cluster; in general the unreddened cluster models contained relatively more blue stars than the reddened models. Several cluster models suggest that large numbers of intrinsically faint stars are not required in the cluster to provide a satisfactory mass-luminosity (visual) ratio of 0.3 to 1.0 (in solar units). As a result of this study a model of a typical globular cluster of Morgan metallic line class II is proposed. (Disser. Abstr.)

44033 STELLAR ROTATION. Strittmatter, P. A. (Inst. for Theoretical Astronomy, Cambridge, Eng.). Annu. Rev. Astron. Astrophys., 7: 665-84(1969).

Problems involved in the theoretical study of rotating stars are reviewed. General questions of radiative and hydrostatic equilibrium in nonspherical configurations are discussed. This is followed by a discussion of stability, viscosity, and convection in rotating media. Methods so far evolved for treating the structure problem, both for uniformly and for differentially rotating stars, are outlined. Work on the atmospheres of rotating stars, with a brief review of the predicted observational quantities is summarized. 91 references. (W.D.M.)

44034 THEORETICALLY PREDICTED COLOR–MAGNITUDE DIAGRAMS FOR CLUSTERS AND THE OBSERVATIONS. Schlesinger, Barry M. (Univ. of Chicago). Astrophys. J., 157: 533-44(Aug. 1969).

Stellar-evolution calculations by Iben were used to predict the appearance of the color–magnitude diagram for clusters of six different ages. The predicted C–M diagrams are compared with observations. The relative number of stars in different parts of the C–M diagram receives special attention. Comparisons at particular ages help in the interpretation of the available observations. An examination of the relation between the luminosity of the stars at the top of the main sequence and that of the stars on the giant branch of young clusters reveals that some of the differences between the C–M diagrams of Magellanic Cloud clusters and of Galaxy clusters that are usually attributed to composition may be age effects. The possibility of a composition difference between M41 and M11 is discussed. If the distance moduli derived at the time of the original observations were correct, the differences between the C–M diagrams of M41 and M11 indicate a difference in composition. It is suggested that most yellow giants in clusters aged 5×10^8 to 10^9 years are burning core helium. (auth)

44035 EARLY SUPERNOVA LUMINOSITY. Colgate, Stirling A.; McKee, Chester (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J., 157: 623-43(Aug. 1969).

The diffusion of radiant energy from spherical expanding matter was analytically and numerically calculated for masses and velocities of model supernova outbursts. The agreement with observation was satisfactory. The production of a large mass fraction of the radioactive isotope ^{56}Ni, which has been predicted from calculations of supernova nucleosynthesis, appears to be critical for the formation of the observed light curves. The radioactive energy from 0.25 $M_\odot$ of ^{56}Ni by the decay process ^{56}Ni → ^{56}Co ($6^d.01$, Ec, 1.72 MeV of γ rays per decay) supplies the radiant energy, 10^{49}

ergs, during the "diffusive release" phase (5 to 20 days) of expansion near maximum. The subsequent decay process, $^{56}Co \rightarrow {}^{56}Fe$ (77 days, Ec, 3.59 MeV of γ rays), in conjunction with progressive γ-ray transparency of the expanding matter, gives rise to the long-time exponential light decay of 35 to 65 days. The velocity distribution with the best fit (Type-I supernovae) gives $\langle V^2 \rangle = (1.6 \times 10^3 \text{ cm sec}^{-1})^2$. For a pure thermonuclear supernova requiring a minimum of 1.4 $M_\odot$ of ^{12}C, the implied kinetic energy is 3 times the maximum available from ^{12}C burning, and 6 times that available from the model calculated by Hansen. This implies the possibility that some supernovae originated from neutron stars. (auth)

44036 EVOLUTION OF DIFFUSE NEBULAE. Mathews, William G. (Univ. of California, San Diego); O'Dell, C. R. Annu. Rev. Astron. Astrophys., 7: 67-98(1969).

The basic evolutionary patterns of diffuse nebulae which can occur and the various techniques which have been used to describe them are reviewed. The present status of theoretical evolutionary models, comparison of theoretical and observed nebulae, bright rims, instabilities, and star formation are considered in detail. Areas of future investigation are mentioned. 128 references. (W.D.M.)

44037 LITHIUM AND BERYLLIUM IN STARS. Wallerstein, George (Univ. of Washington, Seattle); Conti, Peter S. Annu. Rev. Astron. Astrophys., 7: 99-120(1969).

Some of the processes by which lithium and beryllium may be produced and depleted in stellar atmospheres are described. The data are discussed in terms of possible production and destruction processes. Topics considered in detail include methods of analysis, solar lithium and beryllium, lithium and beryllium in normal stars, and lithium and beryllium in Ap and Am stars. 88 references. (W.D.M.)

44038 INFRARED SPECTRA OF STARS. Spinrad, Hyron (Univ. of California, Berkeley); Wing, Robert F. Annu. Rev. Astron. Astrophys., 7: 249-302(1969).

This review of infrared spectroscopy is restricted to stars, and to wavelengths longer than 9000 Å (0.9 μ). A historical sketch of the subject is given. Topics discussed under the general heading of atomic lines include: absorption lines in the 1 μ region, absorption lines in the 2 μ region, absorption lines beyond 2.6 μ, and emission spectra. Items covered under molecular spectra include prediction of molecular concentrations, molecules involving hydrogen and oxygen only, molecules involving carbon, metallic oxides, other molecules, far-infrared spectra, circumstellar and interstellar features in the infrared, and isotopic molecules. Other topics of astrophysical interest mentioned include infrared stellar opacity, chromospheres of late-type stars, and special problems concerning Mira variables. 173 references. (W.D.M.)

44039 ULTRAVIOLET ASTRONOMY. Wilson, R. (Astrophysics Research Unit, Culham, Eng.); Boksenberg, A. Annu. Rev. Astron. Astrophys., 7: 421-72(1969).

Ultraviolet astronomy treated here is defined as the study of objects beyond the solar system in the spectral range between the extinction limits imposed by the Earth's atmosphere (~3000 Å) and the interstellar gas (912 Å). Topics covered include early-type stars, late-type stars (F, G, K, and M), variable stars, galactic nebulae, external galaxies, optical materials, detectors, rockets, balloons, satellites, manned spacecraft, ultraviolet photometry, and ultraviolet stellar spectroscopy. 218 references. (W.D.M.)

44040 EFFECT OF EXCITED NUCLEAR STATES ON STELLAR REACTION RATES. Bahcall, Neta A.; Fowler, William A. (California Inst. of Tech., Pasadena). Astrophys. J., 157: 645-57(Aug. 1969).

The effect of excited states of target nuclei on stellar reaction rates is discussed. Two specific examples, $^{19}F(p,\alpha)^{16}O$ and $^{19}F(p,\gamma)^{20}Ne$, are treated in detail using the available experimental information. A general formula is also given which enables one to take account approximately of the effect of excited nuclear states in the absence of detailed experimental information, if many resonances are present in the compound nucleus within a small energy range. A list is given of nuclei for which low-lying excited states may be important in astrophysical situations. (auth)

44041 ENDOERGIC (p,n) AND (α,n) REACTIONS AND THEIR REVERSE REACTION RATES. Bahcall, Neta A.; Fowler, William A. (California Inst. of Tech., Pasadena). Astrophys. J.; 157: 659-72(Aug. 1969).

Experimental data on cross-sections for endoergic (p,n) and (α,n) reactions near threshold are used to calculate, for twelve nuclei, the corresponding reaction rates in the temperature range 10^8 to 10^{10}°K. Phenomenological expressions for average endoergic (p,n) and (α,n) cross sections and rates are also derived. The reverse exoergic neutron rates are calculated from the experimental (p,n) or (α,n) data, using the reciprocity theorem, and are expected to be valid in the temperature range from 0° to about 10^{10}°K. Cross sections for thermal-neutron reactions are deduced from these rates and compared where possible (three cases) with measured values. Calculations of cross sections and rates for low-energy neutrons have also been carried out using a black-nucleus model; this model yields approximate values for average s-wave thermal-neutron cross sections and rates that are in satisfactory agreement with the results obtained by analyzing the experimental (p,n) and (α,n) data. (auth)

44042 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. XIII. THE HIGH-EXCITATION PLANETARY NGC 4361. Heap, Sara (Univ. of California, Los Angeles); Aller, L. H.; Czyzak, S. J. Astrophys. J., 157: 607-10(Aug. 1969).

The nebula NGC 4361 is a planetary of one of the highest excitations known, and the photoelectric and photographic spectrophotometry yields intensities of the stronger lines. The electron temperature appears to be unusually high (near 24000°K), and most of the atoms are highly ionized. Trebly and quadruply ionized neon is more abundant than doubly ionized oxygen. (auth)

44043 PULSAR ELECTRODYNAMICS. Goldreich, Peter (Univ. of Sydney. California Inst. of Tech., Pasadena); Julian, William H. Astrophys. J., 157: 869-80(Aug. 1969).

Gold has suggested that pulsars are rotating magnetic neutron stars which formed in supernova explosions. The simplest such model was investigated, one in which the magnetic dipole moment is aligned with the rotation axis. Conclusions are as follows: In spite of its intense surface gravity, the star must possess a dense magnetosphere. The particles in the region threaded by those field lines which close within the light cylinder (of radius 5×10^9 P cm, where P sec is the stellar rotation period) rotate with the star. In the corotating zone the space-charge density is 7×10^{-2} B_z/P electronic charges per cm^3, where B_z (in gauss) is the component of magnetic field parallel to the rotation axis. The field lines which extend beyond the light cylinder close in a boundary zone near the supernova shell. Charged particles escape along these lines and are electrostatically accelerated up to energies of 3×10^{12} $ZR_8^2B_{12}P^{-2}$ eV in the boundary zone. (Here, the stellar radius is $R_6 \times 10^6$ cm, and the magnetic field at the polar surface is $B_{12} \times 10^{12}$ gauss.) Beyond the light cylinder the magnetic field becomes predominantly toroidal. Its strength is 6×10^{-9} $R_8^2B_{12}P^{-2}$ r_{pc}^{-1} gauss at a distance of r_{pc} parsecs from the central star. The magnetic torque on the star causes its rotation period to lengthen at the rate P^{-1} $dP/dt = 10^{-8}$ $B_{12}^2R_6^4P^{-2}$ M^{-1} yr^{-1} for an M solar-mass star. The rotational energy lost by the star is transported out by the electromagnetic field and is then transmitted to the particles in the boundary zone. The model is compared with the observed properties of the Crab pulsar (NP 0532) and CP 1919. (auth)

44044 EXPLANATION FOR THE BLUE SEQUENCE OF VARIABLE STARS. Stothers, Richard; Simon, Norman R. (Goddard Inst. for Space Studies, New York). Astrophys. J., 157: 673-81(Aug. 1969).

Nuclear energy of the stellar core is found to be the direct source of energy fed into radial pulsations in two classes of blue variable stars. The μ mechanism (reversal of the gradient of mean molecular weight, which reduces the central condensation) or the β-mechanism (high radiation pressure) can explain the basic variability of β Cephei stars if they are burning hydrogen in their cores, have accreted a helium-rich envelope, and are the luminous secondaries of close binary systems. If the composition reversal does not lead to significant mixing in the envelope, the μ mechanism will operate in inhomogeneous stars of 6 to 95 $M_\odot$. If rapid mixing takes place, the β mechanism will operate in completely homogeneous stars of 12 to 60 $M_\odot$. The β mechanism can also explain the variability of many Wolf–Rayet stars if they are burning helium in their cores, have masses in excess of ~8 $M_\odot$ with a thin or absent hydrogen envelope, and are the luminous primaries of close binary systems. (auth)

44045 THE DOUBLE CEPHEID CE CASSIOPEIAE IN NGC 7790: TESTS OF THE THEORY OF THE INSTABILITY STRIP AND THE CALIBRATION OF THE PERIOD-LUMINOSITY-COLOR RELATION. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Australian National Univ., Canberra); Tammann, G. A. Astrophys. J., 157: 683-708 (Aug. 1969).

Separate light curves in B and V were obtained for the double Cepheid CE Cas a and CE Cas b. The components differ in color and luminosity, with component a brighter and redder than b by 0.07 mag in V and B–V. The observed ratio of the periods is $P_a/P_b = 1.15$, whereas the value predicted from $P\rho^{\frac{1}{2}} = Q$ using

the photometric observations is $P_a/P_b = 1.16 \pm 0.04$, where the variation of Q across the instability strip is taken into account. The effect on the period–luminosity–color relation of a variation of Q of the form $\Delta \log Q = h\Delta(B-V) + k\Delta \log P$ is shown to have no effect on a previous calibration. Galactic Cepheids in clusters and associations give the P–L–C relations, $M_V = -3.425 \log P + 2.52\,(\langle B\rangle^\circ - \langle V\rangle^\circ) - 2.459$, and $M_B = -3.425 \log P + 3.52\,(\langle B\rangle^\circ - \langle V\rangle^\circ) - 2.459$, which reproduce the observed M_V values for the thirteen calibrating stars to within ±0.064 mag average deviation. These equations represent a correction of −0.05 mag to the previous calibration. Expressions for the instability strip in the (M_V, B − V) plane for galactic Cepheids are given. If perturbing effects, such as rotation, mass loss, and different main-sequence formation times, are excluded, the mass ratio of the more massive component to the less massive one must be less than $\mathcal{M}_1/\mathcal{M}_2 = 1.007$ if both stars are to be simultaneously within the Cepheid instability strip near $M_V \simeq -3$. This stringent requirement on the initial mass ratio will be relaxed if such perturbations affect the evolutionary tracks. (auth)

44046 HDE 310376: A RAPID VARIABLE STAR SIMILAR TO SCORPIUS XR-1. Schild, Rudolph E. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 157: 709-15(Aug. 1969).

Spectroscopic and photometric data for the rapid irregular variable HDE 310376 are presented. The star is found to be similar to Sco XR-1 in many ways, but it remains undetected at X-ray wavelengths. Brightness fluctuations usually having the character of flares or bursts as large as 0.2 mag on a time scale of 90 sec are reported. No periodicity or color change is found in the brightness fluctuations. Color changes, primarily variations in the U magnitude over a period of hours, are observed. The spectrum in the blue–violet is ordinarily continuous, although a faint broadened absorption spectrum similar to that of a B5 star is sometimes observed. In addition, emission at λλ 4630 to 4650 and 4686 is always observed and is also variable. Monitoring of the brightness during spectrographic observation suggests that emission is weakest and absorption strongest when the star is most active. From a crude estimate of the distance modulus, it appears that the absolute magnitude is about +3.7. Thus the star lies in the region of the H–R diagram populated by old novae and hot subdwarfs. (auth)

44047 12 CAMELOPARDALIS AND CALCIUM EMISSION IN GIANT BINARIES. Abt, Helmut A. (Kitt Peak National Observatory, Tucson, Ariz.); Dukes, Robert J.; Weaver, W. Bruce. Astrophys. J., 157: 717-20(Aug. 1969).

Bidelman predicted that 12 Cam is a spectroscopic binary because it shows the strong calcium emission that is evidently characteristic of giant binaries of short period. This prediction is confirmed, and orbital elements are derived. The strong calcium emission (1) does not originate near the secondary star, (2) varies slowly with time but not in phase in the eccentric orbit, and (3) does not significantly interfere with the Wilson–Bappu correlation of chromospheric emission width with luminosity. (auth)

44048 THE ATMOSPHERE OF THE HELIUM–CARBON STAR BD +10°2179. Hunger, Kurt; Klinglesmith, Daniel (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: 721-35(Aug. 1969).

A fine analysis of the helium–carbon star BD + 10°2179 was performed by using a grid of constant-flux models. Opacities considered were: H I, H^-, He I, He II, He^-, C II, and electron scattering. The C II opacities were taken from quantum-defect calculations of Peach. The parameters of the models were: T_{eff} = 16000°, 18000°K; log g = 2.5, 3.0; X (mass fraction of hydrogen) = 10^{-3}; Z_c (mass fraction of carbon) = 0.035, 0.152, 0.52. The following quantities were computed: He I line profiles, equivalent widths of twenty C II lines, ionization equilibria of Si II/Si III and S II/S III, $D_{\lambda 3422}$ (He I discontinuity 2^3P^0-k), emergent flux, UBV colors, and bolometric corrections. The model that best represents the observed data was T_{eff} = 16000°K, log g = 2.8, Y = 0.45, X = 0.0001, Z_c = 0.55, and v_t = 0 km sec^{-1}. Great care was taken to include line broadening and turbulent velocity properly. Abundances of thirteen elements were derived and compared with previous analyses. The mass of BD + 10°2179 was estimated to be ≥0.5 $M_\odot$. A preliminary analysis of Popper's star, HD 124448, yielded a carbon abundance of Z_c = 0.17. On the basis of the high carbon content, the helium stars BD + 10°2179 and HD 124448 are considered to be hot carbon stars. (auth)

44049 THE CARBON, NITROGEN, AND OXYGEN ABUNDANCES IN FOUR K GIANTS. Greene, Thomas F. (Univ. of Washington, Seattle). Astrophys. J., 157: 737-56(Aug. 1969).

The abundances, relative to hydrogen, of carbon, nitrogen, and oxygen were determined in the K giants α Boo, α Ser, β Gem, and ε Peg. Use was made of the lines of C_2, CN, C I, and [O I] from spectrograms with dispersions of 2 and 6 Å mm^{-1}. Well-iterated LTE model atmospheres were employed in the reduction, together with a method of analysis which is independent of oscillator strengths. The Sun was used as the comparison star. Weak-line theory was used to predict band intensities and equivalent widths of lines. A graphic-solution technique was employed to obtain the carbon and oxygen abundances, and the nitrogen abundance was then deduced from the CN data. Very rough lower bounds on the $^{12}C/^{13}C$ ratio were determined for each of the four stars by means of rotational lines of the ^{13}CN red (4,0) or (2,0) band. A discrepancy between the observed intensities of the CN red bands and those anticipated on the basis of available oscillator strengths was noted. The final atmospheric abundances, particularly the nitrogen enhancements, were in good agreement with recent predictions based on detailed calculations of stellar evolution, and hence they constitute further evidence that our understanding of stellar nuclear burning and evolution is correct. (auth)

44050 A SEARCH FOR NEON IN THE SPECTRA OF PECULIAR A AND B STARS. Sargent, Anneila I.; Greenstein, Jesse L.; Sargent, Wallace L. W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 157: 757-68(Aug. 1969).

Spectra were obtained in the red region, dispersion 6.8 Å mm^{-1}, for fourteen peculiar and five normal A and B stars, primarily in order to investigate the behavior of neon. As expected on theoretical grounds, the Ne I lines behave like He I, C II, and Si III in the normal stars and increase in strength rapidly with increasing temperature for stars hotter than about B8. Neon was found in the spectra of only four of the peculiar stars, whereas nine of them are blue enough for Ne I to be expected. A comparison of the normal and peculiar stars using curve-of-growth techniques showed that the Si λ4200 class of Ap stars has a deficiency of neon which exceeds a factor of 3. There is marginal evidence that the Mn stars are also deficient in neon. Three peculiar stars are found with a normal neon abundance. They are 3 Cen A, α Scl, and 36 Lyn, none of which falls in any of the usual categories of peculiar stars. However, they have the common property of weak He I lines and normal C II lines. Data are given for lines of He I, C II, O I, and Si II in the red region of the spectra of the stars. A curve-of-growth analysis of the data confirms earlier general conclusions about the behavior of these elements in different categories of peculiar A and B stars. (auth)

44051 NEW EVIDENCE FOR THE OBLIQUE-ROTATOR MODEL FOR α^2 CANUM VENATICORUM. Kodaira, K.; Unno, W. (Carnegie Institution of Washington, D.C. California Inst. of Tech., Pasadena). Astrophys. J., 157: 769-83(Aug. 1969).

The oblique-rotator hypothesis for this spectrum variable was reexamined. Profiles of Si II λλ4128 and 4130 were measured on polarimetric, high-dispersion spectra (1.5 Å mm^{-1}, four polarization components) of α^2 CVn. The position angle of the line of force of the effective magnetic field α was determined as well as the strength of the effective longitudinal magnetic field H*. The observed H*-curve differs slightly in form from that of Babcock and Burd but is in general agreement. Two possible solutions were obtained for the α curve. One of them was found to show the rotary behavior consistent with the observed H* curve and also with the oblique-rotator model proposed by Böhm-Vitense. Strong variations of the profiles of Eu II λ4129, Cr II λ4555, and λ4559 were observed. They coincided well with the predictions given by Böhm-Vitense for her model, suggesting again the validity of the oblique-rotator hypothesis for α^2 CVn. (auth)

44052 THE STRUCTURE AND KINEMATICS OF THE ENVELOPES OF Be STARS: PLEIONE'S SHELL EPISODE, 1938–1954. Limber, D. Nelson (Yerkes Observatory, Williams Bay, Wis.). Astrophys. J., 157: 785-97(Aug. 1969).

An attempt is made to interpret Pleione's 1938–1954 shell episode in terms of a relatively simple model for the structure and evolution of the circumstellar envelope. It is found that the observed variations with time of the intensities, the radial velocities, and the profiles of the shell lines for the higher Balmer lines can be readily understood in terms of a model in which (1) the support of the envelope in the star's equatorial plane is centrifugal, while its support perpendicular to the equatorial plane is thermal, (2) the outward component of velocity, assumed to be independent of time, increases essentially monotonically outward from a value of a few kilometers per second near the star's equator to a value of 60 km sec^{-1} or more at large distances from the star, and (3) the rate at which mass moves into the base of the envelope from the star's equator rises monotonically over a period of several years from zero to a maximum value, and then drops essentially to zero over a much shorter period of time. (auth)

44053 MODEL ATMOSPHERES OF LATE-TYPE STARS. Auman, Jason R. Jr. (Princeton Univ., N. J.). Astrophys. J., 157: 799-826(Aug. 1969).

Model atmospheres with solar abundances were calculated with effective temperatures between 2000 and 4000°K and with gravities corresponding to dwarf, giant, and supergiant stars. The opacity due to water vapor was included. Convection was included by using the Böhm-Vitense mixing-length theory with the mixing length equal to the pressure-scale height. The convection begins at $\tau < 0.05$ in the dwarfs and carries a considerable fraction of the total flux when $\tau \geq 1.0$. In the giants and supergiants the convection does not carry a significant part of the flux until hydrogen begins to ionize at $\tau \sim 10$, although it may occur at small optical depths. The frequency dependence of the emitted fluxes is extremely nongray and does not vary simply with the effective temperature. In order to test the effects of varying the composition, two atmospheres were calculated with $T_e = 4000°K$ and $\log g = 2.0$, with the solar metal abundances reduced by factors of 10 and 100. The emitted flux changed only slightly. In addition, two atmospheres were calculated with $T_e = 3000°K$ and $\log g = 1.0$, with the carbon abundance varied. The strengths of the H_2O features vary much less than the H_2O abundance. (auth)

44054 EXCITATION OF NONSPHERICAL WAVES IN DIFFERENTIALLY ROTATING STELLAR CONVECTIVE ENVELOPES. Kato, Shoji (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 157: 827-34(Aug. 1969).

A possible mechanism which excites nearly horizontal nonspherical waves in differentially rotating stellar convective envelopes is examined. It is shown that such waves can be excited either by the dynamical instability due to the horizontal-velocity shear of differential rotations or by the overstable thermal instability in the convective envelope; the latter results from the cooperative interaction of the superadiabatic temperature stratification and thermal conduction. The excitation by the differential rotation is similar to that of Rossby waves in meteorology. A numerical example is considered for the Sun, and it is suggested that the sinusoidal deformation of quiescent prominences could be explained in terms of the excitation of such waves. (auth)

44055 TRANSFER OF RADIATION IN CIRCUMSTELLAR DUST ENVELOPES. I. EXTREME CASES. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J., 157: 835-42(Aug. 1969).

Transfer of radiation in circumstellar dust clouds was treated for two simplified cases: (1) the thin cloud and (2) the completely opaque cloud. The condition and the consequences of these two cases were examined. For the thin cloud the problem is reducible to a single integral equation that links the emergent infrared spectrum with the dust distribution around the star, and for the completely opaque cloud the problem resembles that of extended stellar atmospheres. (auth)

44056 TRANSFER OF RADIATION IN CIRCUMSTELLAR DUST ENVELOPES. II. INTERMEDIATE CASE. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J., 157: 843-55(Aug. 1969).

The gradual conversion of optical radiation to infrared radiation in the circumstellar dust envelope with spherical symmetry is discussed on the basis that the dust particles not only absorb optical radiation but also scatter it. Scattering is treated as isotropic and coherent, while the temperature at any point in the dust envelope is assumed to be in equilibrium with the combined infrared radiation and the absorbed portion of optical radiation at the point. If the opacity is due to the geometrical cross sections of dust grains, it has been shown that the problem can be expressed by two independent integro-differential equations. If the usual Eddington approximation is applied to these equations and if the opacity obeys some exponential law, as is generally assumed in the study of radiative transfer in spherical atmospheres, the main problem reduces itself to the solving of a Bessel equation with a pure imaginary argument. Consequently, the solution can be expressed analytically, and the optical thickness of the envelope may be derived in terms of the emergent infrared flux relative to the emergent optical flux. Also, the temperature variation in the cloud has been derived. Two cases—one of uniform distribution of dust in the envelope and the other of decreasing distribution outward—have been numerically carried out. Finally, the formal solution is given for the radiation field in the spherical shell of a finite thickness. (auth)

44057 FORBIDDEN TRANSITIONS IN STELLAR SPECTRA. Papers presented at 15th International Conference on Astrophysics, Liege, Belgium, June 24-26, 1968. Mem. Soc. Roy. Sci. Liege, (5), 17: 1-410(1969). (In French and English). (CONF-680658).

A separate abstract was prepared for each of the sections into which this conference was divided. Each section included several papers on related subjects. (A.G.W.)

For abstracts of individual sections see: 44058-44060, 44117, 44133, 44134, 44147, 44169, 44172, and 44290.

44058 FORBIDDEN TRANSITIONS OF EMISSION IN COOL STARS. Mem. Soc. Roy. Sci. Liege, (5), 17: 351-73(1969). (In French and English).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Papers on the following subjects are included in this section: forbidden emission transitions in cool stars, forbidden lines in the spectrum of MHα 328-116, and the spectrum 1966-67 of MHα 328-116. (A.G.W.)

44059 FORBIDDEN TRANSITIONS OF EMISSION IN PECULIAR HOT STARS AND SYMBIOTIC OBJECTS. Mem. Soc. Roy. Sci. Liege, (5), 17: 307-50(1969). (In French and English).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Papers on the following subjects are included in this section: forbidden emission transitions in peculiar hot stars including the symbiotic objects, forbidden emissions in the spectrum of CH Cygni and VV Cephei, infrared spectra of Eta Carinae, forbidden lines in the spectrum of RR Tel 1951-68, spectral variations of Eta Carinae in 1947-49, forbidden lines in the spectrum of HD 51585. (A.G.W.)

44060 ROLE OF FORBIDDEN TRANSITIONS IN ABSORPTION SPECTRA OF THE SUN AND NORMAL AND PECULIAR STARS. Mem. Soc. Roy. Sci. Liege, (5), 17: 187-209(1969).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Forbidden absorption lines appear with appreciable strength either when their transition probabilities are enhanced by local interatomic fields (e.g., He I satellite lines in B stars and pressure-induced vibration-rotation bands of H_2 in Uranus and Neptune) or when the amount of visible material in the line of sight is sufficiently large (of the order of several g cm^{-2} of material of normal composition). The latter effect operates in K giants, in which O I lines are fairly readily detected and provide important clues to the abundances of oxygen and carbon, and in M giants where quadrupole vibration-rotation transitions of H_2 have been found. In the case of the Sun, where the presence of O I was established in 1948, lines of C I, S I, Ca II, Fe II, and Ni II have recently been identified as a result of improved laboratory wavelengths and of the high resolving power and low noise of modern solar spectrographs. These forbidden lines are generally found to have the strength expected from a combination of theoretical transition probabilities and abundances deduced from permitted lines except in the case of Fe II, for which the lines are stronger than expected by a factor between 4 and 10. The identification of Fe II absorption lines in the spectrum of η Carinae by Thackeray (1953) is evidence for the presence of an extended cool or rarefied region. (107 references) (auth)

44061 HYDRODYNAMICS OF THE HELIUM FLASH. Edwards, Alan Charles. Madison, Wis., Univ. of Wisconsin, 1968. 97p.

Thesis.

A detailed model of a 1 $M_\odot$ "extreme Pop II" red giant was hydrodynamically followed through the helium flash. It is found that, essentially regardless of the treatment of time-dependent convection and mixing, the core suffers a mild explosion. The central temperature exceeds 10^{8}°K. At the time the calculations were halted, in the order of 5×10^{48} ergs had been deposited in the core. The core of each model that was computed began its evolution with a 60-second-period low-amplitude oscillation imposed on a general expansion. The convective core could not expand rapidly enough and it slowly heated up. A composition gradient was formed opposed to the convection. Ultimately, the central regions of the core exploded with the temperature rising to 10^{8}°K in a time of the order of 10 seconds. Energy was conserved throughout the calculations to better than 1 part in 10^4. (Diss. Abstr.)

Quasi-Stellar, Radio, and X-Ray Sources

44062 (AD-679894) EAST-WEST LINEAR POLARIZATION DISTRIBUTIONS OF RADIO GALAXIES AT 1418 MHz. Report No. 1968-7. Seielstad, G. A.; Weiler, K. W. (Owens Valley Radio Observatory, Pasadena, Calif.). 1968. Contract N00014-67-A-0094. 137p. CFSTI.

The distributions along a circle of constant declination of the linearly polarized radiation at a frequency of 1418 MHz from

68 extragalactic radio sources were examined. The effective resolution was about 0.8. At places within many sources very high degrees of polarization (>15%), usually accompanied by a constant plane of polarization, were found. Both facts imply the existence of a highly ordered magnetic field. Often other regions within the same source also contained uniform fields, but oriented differently. Less frequently the field is well-ordered over an entire component or even over the entire source. These regions of uniformity can exceed galactic dimensions (about 100 kpc). (auth) (USGRDR)

44063 (AD-679895) POSITIONS AND STOKES PARAMETERS OF SEVEN OH EMISSION SOURCES. Report No. 1968-8. Raimond, Ernst; Eliasson, Baldur (Owens Valley Radio Observatory, Pasadena, Calif.). 1968. Contract N00014-67-A-0094. 40p. CFSTI.

The two-element variable baseline interferometer of the Owens Valley Radio Observatory was used to determine positions of the OH sources near the galactic radio sources W3, Ori A, NGC6334, Sgr B2, W49, W51, and W75. The accuracy of the absolute positions is 4 to 6 sec, that of relative positions of different features belonging to one source is approximately 3 sec. The relative distances between different components of one source seem to be either between 0.0 and 0.1 pC or between 1 and 10 pC. The sample of sources may be too small to conclude whether this is a significant property of OH emission centers. There is a strong indication that four of the OH sources (W3, Ori A, W51 and W75) are located near regions of infrared activity. For three sources, spectra in terms of Stokes parameters are given for the 1665.401-MHz line and for the 1667.358-MHz line. The remaining four sources were observed at 1665.401 MHz only. Strong circular polarization characterizes the spectra of most sources, but many unpolarized and weakly polarized features have been found in the spectra of the Ori A and W51 sources. (auth) (USGRDR)

44064 (AD-679897) EAST-WEST FOURIER TRANSFORMS OF POLARIZATION PARAMETERS OF RADIO SOURCES AT 1418 MHz. Seielstad, G. A.; Weiler, K. W. (Owens Valley Radio Observatory, Pasadena, Calif.). 1968. Contract N00014-67-A-0094. 50p. CFSTI.

As part of a continuing study employing the Owens Valley Radio Observatory's twin-element interferometer to provide high angular resolution measurements of the various radio source properties, the Fourier transforms of the distributions of the Stokes parameters Q, U, and V were measured at several antenna spacings along an east–west baseline. The present paper catalogs these measurements, while a subsequent paper will interpret them in terms of the structure of the polarized radiation along a circle of constant declination. (auth) (USGRDR)

44065 (AD-681708) DISCOVERY OF AN INTENSE OH EMISSION SOURCE. Report No. 1969-1. Eliasson, B.; Bartlett, J. F. (Owens Valley Radio Observatory, Pasadena, Calif.). 1969. Contract N00014-67-A-0094. 9p. CFSTI.

This letter reports the discovery of a bright OH emission source at 1612.231 MHz in the constallation Canis Major. The source was discovered with the Owens Valley interferometer in October, 1968. There is a bright infrared object listed close to the position of the source in the Caltech catalog of infrared stars (Neugebauer and Leighton 1968). This infrared object has been identified with an irregular variable, VY Canis Majoris. (auth) (USGRDR)

44066 (AD-685251) POLARIZATION MEASUREMENTS OF EXTRAGALACTIC RADIO SOURCES AT 3.12 CM WAVELENGTH. 2. Report No. 1969-2. Berge, G. L.; Seielstad, G. A. (Owens Valley Radio Observatory, Pasadena, Calif.). 1969. Contract N00014-67-A-0094. 23p. CFSTI.

The two-element interferometer at the Owens Valley Radio Observatory was used in late 1967 to measure the integrated polarization, both linear and circular, of 32 extragalactic radio sources at a wavelength of 3.12 cm. In addition, flux densities of 103 radio sources were also measured. (auth) (USGRDR)

44067 (AD-685252) A GENERAL DISCUSSION OF THE BRIGHTNESS DISTRIBUTION OF EXTRAGALACTIC RADIO SOURCES. 3. Report No. 1969-3. Fomalont, Edward B. (Owens Valley Radio Observatory, Pasadena, Calif.). 1969. Contract N00014-67-A-0094. 52p. CFSTI.

The brightness distribution of extragalactic radio sources is discussed, based mainly on recent observations at the California Institute of Technology. The paper concentrates on displaying general properties of radio sources rather than a discussion of individual sources. The angular scale and the morphological types of radio structures are discussed, a method for analyzing the structure of a large sample of sources using the visibility function is outlined, and the spatial properties of the radio structure and galaxy are discussed. (auth) (USGRDR)

44068 (AD-685253) HIGH-RESOLUTION OBSERVATIONS OF RADIO SOURCES. 4. Report No. 1969-4. Cohen, Marshall H. (Owens Valley Radio Observatory, Pasadena, Calif.). 1969. Contract N00014-67-A-0094. 106p. CFSTI.

Three principal methods are used to obtain high angular resolution at radio wavelengths: interferometry, lunar occultations, and interplanetary scintillations. These methods are reviewed and compared. Typical results are presented. A general tabulation of all interferometric results at resolution higher than one second of arc is also included. (auth) (USGRDR)

44069 (AD-685668) A MEASUREMENT OF THE GALACTIC MAGNETIC FIELD USING THE PULSAR PSR 0833-45. Report No. 1969-5. Ekers, R. D.; Lequeux, J.; Moffet, A. T.; Seielstad, G. A. (Owens Valley Radio Observatory, Pasadena, Calif.). 1969. 14p. CFSTI.

The radiation from PSR 0833-45 is strongly linearly polarized. Measurements at 21, 18, and 13 cm show a rotation measure of 33 ± 5 radian/m^2. Combined with the published value of the dispersion measure, this yields a mean value of 0.73 ± 0.13 μG for the longitudinal component of the galactic magnetic field along the inner face of the Orion arm. (auth) (USGRDR)

44070 (AD-687693) STUDIES OF THE PHYSICAL PROPERTIES OF QUASI-STELLAR OBJECTS. Feldman, P. A. (Stanford Univ., Calif. Inst. for Plasma Research). Mar. 1969. Contract N00014-67-A-0112. 86p. (SU-IPR-285). CFSTI.

This work deals with quasi-stellar objects as cosmologically distant entities, in accord with the currently accepted interpretation of their redshifts. Attempts are made to understand the physical properties of these objects within the basic framework of the "galactic-flare" model of Sturrock, which was originally developed in connection with a theory for the major explosions associated with quasars and radio galaxies. The primary aim of the work is to explain the enormous luminosities, especially in the infrared, that must be produced by cosmologically distant quasars (and certain active galaxies). The resultant explanation turns out to be successful not only in this respect but also in leading to a satisfactory model encompassing a number of other aspects of the quasar phenomenon. A specific model for the quasar "archetype" 3C 273B is discussed quantitatively. It is shown that the physical characteristics of the line-emission region and of the meter-wave radio region are consistent with those adopted for the source of strong infrared continuum radiation. Suggestions are made for possible observations that could help to verify the proposed model. (auth) (USGRDR)

44071 (N-69-22113) PHYSICAL PROPERTIES OF THE RADIO-EMITTING REGION IN SCO X-1. Riegler, Guenter R.; Ramaty, Reuven (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1969. 14p. (NASA-TM-X-63507; X-611-69-123). CFSTI.

On the basis of recent observations it was deduced that the radio emission from Sco X-1 is synchrotron radiation of relativistic electrons in an extended low-density region surrounding a denser core which produces the x-ray and optical continua. The linear dimensions of the radio-emitting region are larger than 10^{12} cm, the ambient density is less than 10^9 cm^{-3} and the radiation could typically be produced by electrons of about 15 MeV in a magnetic field of a few gauss. (auth) (STAR)

44072 (PB-183997) OBSERVATIONS OF THE 21-cm LINE TOWARD HIGH-LATITUDE STARS. Final Report. (Virginia Univ., Charlottesville). 1969. 1969. 9p. CFSTI.

The paper contains reports on the following: 21-cm observations toward high-latitude stars, motions of high-latitude clouds, frequency dependence of polarization of pulsar CP 0328, construction of a 21-cm telescope, study of limited aperture synthesis, observations of sources near the north celestial pole at 2295 MHz, and study of clustering of radio sources at meter wavelengths. (USGRDR)

44073 (PB-184050) A STUDY OF LATITUDE DEPENDENCES OF RADIO STAR SCINTILLATION. Final Report. Swenson, G. W. Jr.; Flaherty, B. J. (Illinois Univ., Urbana. Dept. of Electrical Engineering). Mar. 1969. 4p. CFSTI.

To verify the existence of a mid-latitude scintillation boundary for cosmic sources, similar to that observed with radio transmissions from earth satellites, the University of Illinois has had in operation three radio interferometers in the 73.8 MHz radio astronomy band. They have been in operation from the minimum phase of the present solar cycle (January, 1963) until the near maximum phase (January, 1969). This long period of observation was required to collect sufficient data to have meaningful statistics. The percent of time that scintillation will be observed increases with increased solar activity. At present all the stations have been closed, and data are being prepared for analysis. (USGRDR)

44074 (PB-184053) EQUIPMENT FOR X-RAY EMISSION OF THE GALACTIC CENTER REGION BY LUNAR OCCULTATION. Final Report. Bowyer, C. Stuart (California Univ., Berkeley. Space Sciences Lab.). Jan. 4, 1969. 13p. CFSTI.

The objectives of this experimental program fall into the following main categories: to monitor short-term variations in the flux of Sco XR-1 and to correlate these variations with variations in the light flux from these sources; to obtain the precise locations and the high-energy spectra for known x-ray sources; to scan unusual astronomical objects for evidence of x-ray emission; and to obtain information on the gamma-ray background flux. (USGRDR)

44075 QUASISTELLAR OBJECTS. Schmidt, Maarten. Annu. Rev. Astron. Astrophys., 7: 527-52(1969).

This review is essentially a progress report covering the years 1967 and 1968. Topics covered include identification of QSO's, emission-line spectra and redshifts, continuous energy distribution, absorption-line spectra, radio properties, the nature of QSO's, evolution, cosmological aspects, and models and mechanisms. 296 references. (W.D.M.)

44076 SYNTHETIC-APERTURE RADIO TELESCOPES. Swenson, G. W. Jr. (Univ. of Illinois, Urbana). Annu. Rev. Astron. Astrophys., 7: 353-74(1969).

Topics discussed in some detail include the theory of aperture synthesis, early applications of aperture synthesis, supersynthesis, technical problems of aperture synthesis, antennas and the mobility system, design of supersynthesis arrays, and existing and proposed supersynthesis instruments. 35 references. (W.D.M.)

44077 HIGH-RESOLUTION OBSERVATIONS OF RADIO SOURCES. Cohen, Marshall H. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys., 7: 619-64(1969).

Three principal methods, lunar occultations, interplanetary scintillations, and interferometry are discussed. The theory of the measurement with each is outlined, and an attempt is made to relate the techniques to each other. For lunar occultations the theory is set out in more detail because of some new results relating to the resolution limit. Observational techniques and results are discussed, but only for interferometry is a catalog of sources given. 182 references. (W.D.M.)

44078 A THEORETICAL ANALYSIS OF METHODS OF INTERPRETING RADIO-LINE DATA FROM H II REGIONS. Hjellming, Robert M. (National Radio Astronomy Observatory, Green Bank, W. Va.); Andrews, M. H.; Sejnowski, T. J. Astrophys. J., 157: 573-82(Aug. 1969).

The best form of analysis of data on radio recombination lines from H II regions is shown to require inclusion of both non-LTE effects and highly concentrated clumping. The principal physical effect of clumping is to reduce considerably the line enhancements predicted by the non-LTE theory. Theoretically, all radio recombination lines emitted by the same mass of ionized gas should, within the error limits, be interpretable in terms of a single electron temperature. (auth)

44079 THE EVOLUTION OF HIGH-DENSITY, DUST-FILLED H II REGIONS. Mathews, William G. (Univ. of California, San Diego). Astrophys. J., 157: 583-99(Aug. 1969).

Recent observations suggest that massive stars may form within dense, dust-laden neutral clouds which become ionized as the star approaches the main sequence. An evolutionary dynamic model is presented for such a nebula, and the thermal radio continuum is given as a function of time. Radio time variations may be observable. The theory for sputtering of charged grains is reviewed, and the possibility of dust-limited H II regions is investigated. Dust inside H II regions will be sputtered away on short time scales if the electron density exceeds about 10^3 cm^{-3}. Radiation pressure on the dust within the surrounding neutral gas will affect the evolution of initially dusty, high-density H II regions, but not greatly. Finally, observations of W49 A, a compact H II region, are shown to be in conflict with the properties of the most massive stars as they are currently understood. (auth)

44080 MECHANISMS OF FORMATION OF JETS IN QUASARS. Nedyalkov, I. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 105-13(1969). (In Russian).

In several quasars (3C273, 2C48, and 3C196) jets are observed that emit strong electromagnetic radiation. The formation of these jets has been explained either as a result of the interaction of strong magnetic fields with gases, or as a result of general-relativistic instability in supermassive objects. In this paper two models of quasars are discussed in which there is a simple explanation for the formation of the jets. In the first model it is supposed that in quasars there exist supermassive bodies, which are in fast rotation. By means of an unknown mechanism, large portions of gases are ejected in direction of the axis of rotation. As an effect of the conservation of the moment of momentum the axis of the rotating body conserves its direction. The consequence is that the ejected portions of masses are arranged in a straight line, thus forming a rectilinear jet. In the second model it is supposed that the jets are formed by a mixture of photon gas and plasma, which is outflowing from a gigantic plasma shell. It is assumed that the shell is formed in a galactic nucleus, the gravitational field of which makes the shell stable. As the outflow is progressing, the diameter of the shell diminishes until a critical size is reached in which the shell is not stable. The subsequent collapse forms a supermassive star of the Fowler type, which manifests itself as a quasar. (auth)

44081 HYDROXYL AND WATER MASERS IN PROTOSTARS. Litvak, M. M. (Massachusetts Inst. of Tech., Lexington). Science, 165: 855-61(Aug. 29, 1969).

There are stringent conditions on any chemical process that might be responsible for the population inversion and the observed properties of the OH maser. So stringent are they that no such process is likely to be found. On general grounds, the high densities and narrow line widths would imply unsaturated amplification. This is most sensitive to small differences in protostar conditions. Yet the intensities are comparable for the different emitters, despite different line widths and polarizations, which attests to a variety of conditions. The emissions from the excited rotational states become progressively weaker at higher positions in the rotational ladder, not, as expected, for excitation temperatures greater than 700°K and for the unsaturated amplification that is required by a total density greater than 10^{10} cm^{-3}. The time variations, polarization, and preference for certain hyperfine components are inexplicable at high densities. Furthermore, Zeeman splittings would be much larger than observed. However, in the outer parts of the cloud, with optical pumping from a shocked OH layer and heated grains, the conditions are favorable for maser emission with the observed properties. (auth)

44082 POLARIZATION OF INTERSTELLAR OH EMISSION. Coles, William Arthur. San Diego, Calif., Univ. of California, 1968. 89p.

Thesis.

The observation program included the following "main-line" sources: W3, W22, W24B2, W33, W43, W49, Orion A, Cassiopeia A, and NGC6334. The "satellite-line" sources observed were: W28, G5.9-0.4, W43, and W51. "Normal" emission from a dark cloud at $l = 168.74°$ and $b = 15.50°$ showed less than 10% polarization. No polarization was detected in any absorption feature, with an upper bound of 2% Cassiopeia A. The source W33 at 1665 MHz, but not at 1667 MHz, showed a strong variation from February to May and also during a 10 day interval in May. Observations of W3 at 1665 MHz during February and May are self-consistent, but they disagree in detail with previous measurements. It is believed that this is, in fact, a time variation in the source. The source W43 has a triplet of main-line emission features which fit a Zeeman splitting interpretation. Several other sources have complex multiplets of emission features which are open to this interpretation. The implied field strengths are of the order of 5×10^{-4} gauss. The satellite-line sources fall naturally into two subdivisions. In the first class, corresponding features appear in emission at one transition frequency, and in absorption at the other frequency. These features tend to be broad, weak, and unpolarized. The second class has emission at one of the satellite transitions only. The emission is relatively strong and narrow. It tends to be weakly polarized, in a complex manner, suggesting the overlapping of many features. (TSS)

44083 OBSERVATIONS OF INTERSTELLAR MOLECULAR HYDROGEN. Werner, Michael Wolock. Ithaca, N. Y., Cornell Univ., 1968. 203p.

Thesis.

An observational program for the detection of interstellar molecular hydrogen has been conceived and carried out. The observational technique involves a search for vibration–rotation emission lines from the ground electronic state of H_2. These lines are produced in a resonance fluorescence process initiated by an electric absorption in the ultraviolet bands of H_2, followed by de-excitation into an excited vibrational level of the ground electronic state and a cascade into the ground vibrational level. A detailed theory of this radiative cascade process has been developed. Two lines in the (3-0) band of H_2, the O(2) line at 8748 Å, have been sought. The apparatus used was a pressure-scanned Fabry–Perot interferometer developed at the University of Rochester. Observations were made at the Kitt Peak National Observatory. The sources observed in this program included the Orion Nebula, the OH emission source W3, a bright rim in the H II region IC 1396, and a portion of an opaque interstellar cloud near ρ Ophiuchus. All observations were made with a 1.2′ field of view. For the latter three sources, an upper limit of ~10^5 photons/cm^2-

sec-sr has been set on the flux in each of the lines observed. (TSS) (Diss. Abstr.)

44084 THE HARD-SPHERE FERMI GAS AND FERROMAGNETISM IN NEUTRON STARS. Rice, M. J. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Lett., 29A: 637-8(Aug. 11, 1969).

Landau's Fermi liquid function for a hard-sphere gas of neutrons is used to predict the onset of ferromagnetism for this system at densities in the range of gravitationally stable dense neutron matter. (auth)

44085 PERIODIC INTENSITY FLUCTUATIONS IN PULSARS. Taylor, J. H. (Harvard Coll. Observatory, Cambridge, Mass.); Jura, M.; Huguenin, G. R. Nature (London), 223: 797-9 (Aug. 23, 1969).

Eight pulsars were searched for signs of periodic modulation of the pulse amplitudes, such as had already been reported for two pulsars. Five more examples of this phenomenon were found. (auth) (UK)

44086 SEARCH FOR AN OPTICAL REMNANT OF THE CASSIOPEIA A SUPERNOVA. van den Bergh, S. (California Inst. of Tech., Pasadena); Dodd, W. W. Nature (London), 223: 814-15 (Aug. 23, 1969).

The motions of the luminous filaments associated with the radio source Cas A were studied using plates obtained between 1951 and 1968 with the 200-inch Hale telescope, and the position of the center of expansion found from these motions is shown graphically. Assuming a uniform rate of expansion, the explosion which gave rise to Cas A was estimated to have taken place in AD 1667 ± 8, and it was found that the remnant of Cas A must be at least five magnitudes fainter than the central star of the Crab Nebula. This may be accounted for by the supposition that type-II supernovae, such as Cas A, do not leave a stellar remnant; alternatively, it might be assumed that the absorption in the direction of Cas A is very much greater than in the direction of the Crab Nebula. The fact that the supernova outburst of AD 1667 was not observed tends to support the assumption that the absorption in the direction of Cas A is large, and the absence of [O II] λ 3727 in the spectra of the moving filaments lends further support to this assumption. (UK)

44087 DO PULSARS TURN OFF? Ostriker, J. P.; Gunn, J. E. (Princeton Univ., N. J.). Nature (London), 223: 813-14 (Aug. 23, 1969).

It is stated that there are strong arguments, nearly independent of the chosen model, indicating that pulsars "turn off" in a time which is short compared with the age of the Galaxy. These arguments are discussed, and it is shown that this behavior is to be expected on the basis of established physical theory and the particular model which the authors and others have been developing (Nature 221:454 (1969); Phys Rev. Lett. 22:728 (1969)), and that the absence of long-period pulsars can be quantitatively understood and fairly accurate predictions can be made for the rate of change of period from other observed quantities. With one exception the periods of pulsars increase or remain constant, and for the well observed pulsars it will take $\approx 10^7$ yr for their period to double at the present rate of increase. There are, at the last count, 11 pulsars with periods between 1.0 and 2.0 sec, but only one with a period between 2.0 and 4.0 sec. The question arises as to what has happened to the large number of ≈1.5-pulsars that existed 10^7 yr ago. Either the periods of these pulsars must have stopped lengthening before passing 2.0 sec, or the radio luminosity must have decreased, or both; and it must have taken $<10^7$ yr for this to happen. It is shown that observations indicate that both processes occur on a time scale of $\sim 4 \times 10^6$ yr. Explanations of the deficit may be that the pulsars do not continue to emit pulses for 10^{10} yr, or that geometrical effects prevent the observation of a large fraction of the nearby objects. These possible explanations are discussed. It is concluded that the conductivity in neutron stars is such that, after several millions of years, any initial magnetic field will have substantially decayed, the period will have reached a maximum value of 1 to 2 sec, and the pulsed luminosity will have decreased considerably. (UK)

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Refer also to abstracts 43323, 44238, and 44336.

44088 (AD-679977) SOLAR PROTON OBSERVATIONS AT SYNCHRONOUS ALTITUDE DURING 1967. Report for January 1-June 30, 1968. Paulikas, G. A.; Blake, J. B. (Aerospace Corp., El Segundo, Calif.). Sept. 1968. Contract F04701-68-C-0200. 32p. (TR-0200(4260-20)-2; SAMSO-TR-68-444). CFSTI.

Measurements of solar protons in the 5- to 70-MeV energy interval obtained at synchronous altitude during 1967 are presented. The major contributions to the integrated flux were the events of January 28 and May 23, 1967. (auth) (USGRDR)

44089 (AD-681456) SUNSPOT MOTION STATISTICS. Report No. Scientific-3. Coffey, Helen E. (Colorado Univ., Boulder). Nov. 1968. Contract F19628-67-C-0304. 75p. (AFCRL-68-635). CFSTI.

Basic characteristics of sunspot movement are covered, as developed in previous statistical investigations. Some of the difficulties in relating spot movements to large-scale photospheric motions, and possible terrestrial atmospheric analogues, are discussed. The differential rotation rate is studied. Bigger spot group speeds in longitude and latitude drift patterns are studied. The correlation between longitude and latitude motions indicates momentum transport toward the equator at all latitudes studied. Correlations involving various spot area parameters and spot motions were also computed. Possible explanations of the significant results are discussed. (auth) (USGRDR)

44090 (AD-681615) SOLAR WIND AND THE SHOCK WAVE PROPAGATING FROM FLARES THROUGH INTERPLANETARY SPACE. Dvoryashin, A. S. Translated from Izv. Krym. Astrofiz. Observ., 36: 126-33(1967). 16p. (FTD-MT-24-155-68). CFSTI.

The spiral structure of the interplanetary magnetic field, resulting from continuous radial expansion of the solar corona in interplanetary space, is confirmed by the results of an investigation of temporal regularities in absorption phenomena in the polar cap due to high-energy particles from proton flares. On the basis of a sufficiently large number of cases it was found that the propagation velocity of the agent, responsible for the sudden commencement (SC) of magnetic storms, through interplanetary space is higher by a factor of 2 to 4 than that of the solar wind. It is concluded that the SC of magnetic storms is due to the passage of the Earth through a collisonless shock front. In one case the width of the front computed for a collisionless shock wave at small Mach numbers coincided with that of the front measured directly in interplanetary space. The structure of the interplanetary magnetic field, deformed by the propagating shock wave from the Sun is discussed. (auth) (USGRDR)

44091 (AD-682249) AN ANALYSIS OF SUDDEN IONOSPHERIC DISTURBANCES ASSOCIATED WITH THE PROTON FLARE OF 1522 UT, AUGUST 28, 1966. Donnelly, Richard F. (Space Disturbances Lab., Boulder, Colo.). Nov. 1968. 36p. (SDL-6; ERL-92). GPO $0.40.

The report consists of two main parts: (1) a summary of the x-ray and extreme ultraviolet (euv) radiation deduced from ionospheric data for the proton flare of August 28, 1966; and (2) a detailed discussion of the analysis of this ionospheric data as an example of our general analysis procedures for sudden ionospheric disturbances, especially sudden frequency deviations. The ionospheric data show that a very large burst of extreme ultraviolet radiation of about 7 ergs/cm^2 sec above the Earth's atmosphere occurred during the flare. The time dependence of this burst agrees closely with the 8,800- and 10,700-MHz solar radio bursts, but does not agree with bursts at frequencies ≤2800 MHz. The soft x-ray enhancement deduced from ionospheric data peaked about 4 min after the euv burst. (auth) (USGRDR)

44092 (AD-683789) INTERPLANETARY SECTOR STRUCTURE IN THE RISING PORTION OF THE SUNSPOT CYCLE. Report No. Series 9, Issue 68. Wilcox, John M.; Colburn, David S. (California Univ., Berkeley. Space Sciences Lab.). Feb. 4, 1969. Contract Nonr-3656(26). 16p. CFSTI.

The interplanetary sector structure during the rising portion of the sunspot cycle in 1966 and 1967 was investigated. The sector pattern is often quasi-stationary for a few rotations, followed by an appreciable change in the next rotation. When a sector boundary passes the Earth, geomagnetic activity tends to increase, an effect rather similar to that observed near sunspot minimum. The recurrence period of the interplanetary field during the interval investigated was 27.5 ±0.1 days. (auth) (USGRDR)

44093 (AD-683790) CORONAL STRUCTURE AT THE SOLAR ECLIPSE OF SEPTEMBER 22, 1968: PREDICTION AND OBSERVATION. Report No. Series 10, Issue 4. Schatten, Kenneth H. (California Univ., Berkeley. Space Sciences Lab.). Feb. 14, 1969. Contract Nonr 3656(26). 8p. CFSTI.

The coronal structure to be expected during the solar eclipse of September 22, 1968 has recently been published. Waldmeier has made available a sketch that he prepared from photographs obtained during this eclipse. Many of the features seen in the eclipse (streamers, open-rayed configurations, and condensations) were in good qualitative agreement with those predicted from the model. Comparisons of the exact shape of many features may lead to improvements in the model and to a better understanding of coronal processes. (USGRDR)

44094 (AD-684438) ON THE SOLAR FLARE OF JULY 8, 1968. Report No. 69-11. Van Allen, J. A.; Wende, C. D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb. 1969. Contract Nonr-1509(06). 12p. CFSTI.

Absolute solar x-ray flux in the wavelength range 2 to 12 Å is reported for the 3B flare of July 8, 1968. The measurements were made with satellites Explorer 33 and 35. Also given is the solar radio flux density at 15,375 MHz as observed by the North Liberty Radio Observatory. (auth) (USGRDR)

44095 (AD-684719) CORRELATION BETWEEN SOLAR RADIO BURSTS AND SUDDEN FREQUENCY DEVIATION EVENTS. Report No. Scientific-1. Strauss, Federico M.; Papagiannis, Michael D. (Boston Univ., Mass.). Jan. 1969. Contract F19628-68-C-0097. 24p. (AFCRL-68-654). CFSTI.

Solar radio bursts observed at 606, 1415, 2695, 4995, and 8800 MHz were correlated with Sudden Frequency Deviations (SFD) measured at Boulder, Colorado, in the signals of WWI originating in Havana, Ill. The correlation reaches a not-very-pronounced maximum near 5000 MHz, and it is higher for stronger events (both large bursts and large SFD's). It increases monotonically with the size of the SFD's correlated with radio bursts observed on centimeter wavelengths, but shows a decrease for SFD's of intermediate size correlated with bursts observed in the decimeter region. Of the five frequencies (8.9, 9.9, 11.1, 12.1, and 13.0 MHz) of WWI used to measure SFD's over the above-mentioned ray path, the correlation of the events observed at 9.9 MHz was less than half the mean correlation value obtained from the other four frequencies. The correlation was high for radio bursts with a maximum in the range between 1000 and 5000 MHz and low for radio bursts with intensity spectrum decreasing with frequency in the range from 606 to 8800 MHz. The results are also compared with a similar correlation analysis between solar radio bursts and SCNA events. (auth) (USGRDR)

44096 (AD-685767) BIBLIOGRAPHY OF SOLAR PROTON EVENTS AND RELATED PHENOMENA. Report No. Scientific-4. King, H. S.; Wright, R. R.; Ko, H. C. (Ohio State Univ. Research Foundation, Columbus). Feb. 1969. Contract AF19(628)-6145. 97p. (AFCRL-69-100). CFSTI.

The ability of the Sun to emit high-energy cosmic-ray particles was discovered by Forbush in 1946, and the study of these particles has become important to an understanding of solar physics and solar-terrestrial relationships. As an aid to the future study of space weather forecasting, a list was compiled of published works related to the forecasting of solar proton events. (auth) (USGRDR)

44097 (AD-686019) THE NRL SOLRAD 9 SATELLITE SOLAR EXPLORER B 1968-17A. Kreplin, Robert W.; Horan, Donald M. (Naval Research Lab., Washington, D. C.). Mar. 24, 1969. 51p. (NRL-6800). CFSTI.

The SOLRAD 9 satellite, launched March 5, 1968, carried instruments to measure solar radiation in the x-ray region from 0.1 to 60 Å and in the far-ultraviolet from 1080 to 1350 Å. These spectral regions are covered by a number of band-sensitive ionization-chamber photometers, Geiger counters, and scintillation counters. An aspect sensor was also included to measure the angle between the solar direction and view direction of the photometers for correction of photometer measurements in case of failure of the attitude-control system. The satellite transmits its x-ray and ultraviolet measurements in real time via an FM/AM telemetry system operating in the 136-MHz band. (auth) (USGRDR)

44098 (AD-686471) STUDIES OF THE SOLAR ATMOSPHERIC GENERAL CIRCULATION. Final Report, February 2, 1966-January 31, 1969. Starr, Victor P. (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). Feb. 28, 1969. 23p. (AFCRL-69-93). CFSTI.

The research reviewed was directed toward the development of a method of objective forecasting of solar flare phenomena. This was done through efforts to construct mathematical models of the outer layers of the Sun, to be solved by machine integration in a manner similar to the procedures used in meteorological forecasting on a hemispheric or global scale. In the solar case, magnetic terms are included and various other complicating factors are treated. One preliminary model was prepared for purposes of orientation. This much simplified model was solved largely by analytical methods. It indicated the general feasibility of the approach used, and displayed many details in agreement with observations. A second global two-layer model was designed and partially tested. It showed, when properly adjusted, an equatorial acceleration, a dynamo action which actually is probably too vigorous, and a tendency to oscillate with a period of the general order of the solar cycle. The two hemispheres showed a general opposing magnetic polarity. Further testing is now in progress. (auth) (USGRDR)

44099 (AD-687745) FLARE OCCURRENCE TOMORROW AS A FUNCTION OF AREA AND FLARINESS OF SUNSPOT TODAY. Air Force Surveys in Geophysics No. 210. Reilly, Alfred E.; Enger, Isadore; Pavlowitz, Abraham (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Apr. 1969. 15p. (AFCRL-69-148). CFSTI.

An objective technique has been developed for estimating the probability of occurrence of solar flares in a particular sunspot group using both the size of the sunspot group and its "flariness." Tables are given which indicate the probability that at least one flare of importance two or greater will occur tomorrow, given the area and flariness of the sunspot group today. (auth) (USGRDR)

44100 (AD-687768) SOLAR VELOCITY FIELDS: FIVE MINUTE OSCILLATIONS AND SUPERGRANULATION. Tanenbaum, Andrew S.; Wilcox, John M.; Frazier, Edward N.; Howard, Robert (California Univ., Berkeley. Space Sciences Lab.). May 2, 1969. Contract Nonr-3656(26). 36p. CFSTI.

One-dimensional magnetograph scans were used to study the five-minute photospheric velocity oscillations and the supergranulation. The oscillations in wing brightness lead the oscillations in velocity by less than 90° in the photosphere, and about 90° in the chromosphere, suggesting that they are waves at lower levels and standing waves at higher levels. Downward flows were observed to be coincident with the chromospheric network, confirming the hypothesis that material is flowing downward at supergranular boundaries. (auth) (USGRDR)

44101 (N-69-23135) EFFECT OF $2 < \lambda < 12$ A SOLAR X-RAYS ON THE IONOSPHERE BETWEEN 60 AND 100 km. Sengupta, P. R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Mar. 1968. Contract NAS5-9076). 61p. (NASA-CR-100604). CFSTI.

Computations were made in order to evaluate the ionospheric effects caused by the observed λ 2 to 12 Å x-ray quiescent flux and flare flux. Of 72 solar x-ray flares having F(2 to 12 Å) greater than 3×10^{-3} erg/cm^2 sec as recorded by Explorer 33, 67 are found to be accompanied by reported S.I.D.'s in which the electron density of the ionosphere between 60 to 100 km undergoes a rapid increase during a few minutes. These rapid increases in electron density are presumably caused by the enhanced x-ray flux in the wavelength range λ 1 to 10 Å because softer x-rays would be completely absorbed above 100 km and harder x rays would penetrate below 60 km without significant attenuation at higher altitudes. The altitudes for peak electron production range from 99 km for 10 Å x rays down to 58 km for 1 Å x rays. The electron production rate equations were solved using a quiescent x-ray energy spectrum and a mean flare x-ray energy spectrum. (auth) (STAR)

44102 (N-69-24915) EAST-WEST ASYMMETRY IN THE SOLAR WIND VELOCITY. Siscoe, G. L.; Goldstein, B.; Lazarus, A. J. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Aug. 1968. Contract NAS2-3793. 14p. (NASA-CR-73323). CFSTI.

An east-west asymmetry may exist in the solar-wind velocity due to the action of a well-known mechanism, namely, the influence of the solar rotation on the interaction between fast and slow streams. The mechanism predicts fast streams tend to come from the west and slow ones from the east with respect to the average solar-wind direction. It is noted that if there is a correlation between density and velocity, a measurement of the average azimuthal wind component is not sufficient to determine the angular momentum flux. Experimental evidence from Pioneer 6 indicates that about 50% of the east-west variations in flow direction with periods around 4 days (the largest period studied) may be due to the fast stream-slow stream interaction. The percentage decreases for shorter periods. (auth) (STAR)

44103 (N-69-25369) SOLAR FLARE RADIATION PROTECTION REQUIREMENTS FOR PASSIVE AND ACTIVE SHIELDS. French, Francis W. (Avco-Everett Research Lab., Everett, Mass.). Mar. 1969. Contract NAS8-21392. 48p. (CONF-690119-1; NASA-CR-98420; RR-331). CFSTI.

From AIAA Aerospace Scientific Meeting, New York.

The degree of protection from solar flare radiations required by astronauts on interplanetary flights is investigated if the protection is provided by passive means (bulk shielding), and active means (plasma radiation shielding). Anticipated solar flare radiation environments postulated in several recent studies are examined and found to fall into two general categories. Radiobiological tolerance criteria based on early skin and blood-forming organ responses are discussed. Several approaches to selecting a mission radiation exposure criterion are considered, and example criteria suggested for illustrative purposes. Curves are presented of dose vs shield thickness and plasma radiation shield voltage with probability of exceeding a given dose as a parameter. These curves

are used to obtain requirements for the two types of shielding. Results are compared on several bases. (auth) (STAR)

44104 (N-69-30268) MAJOR SOLAR AND SOLAR INDUCED PHENOMENA DURING THE 20th SOLAR CYCLE. PART 2. CONDITIONS FOR EARLY DETECTION OF SOLAR PROTON EVENTS. Final Report. Jonah, Fred C. (LTV Aerospace Corp., Dallas, Tex. Missiles and Space Div.). June 19, 1969. Contract NAS9-7134. 56p. (NASA-CR-101706). CFSTI.

A summary of 43 major solar events for the years 1964 through 1968 is presented. All solar activity normally associated with the active region at the time of the flare, radio-frequency emissions, or a solar proton stream is also included. Where possible, flare-day solar-region data, sunspot magnetic class and area, and the Carrington longitude are included. These observations were made using deep space probes, and/or with maximum PCA absorption ≤2 dB, and satellites. Tables are also given. (auth) (STAR)

44105 X RAYS FROM THE SUN. Neupert, W. M. (Goddard Space Flight Center, Greenbelt, Md.). Annu. Rev. Astron. Astrophys., 7: 121-48(1969).

The techniques of solar x-ray observation are summarized, with emphasis on those aspects that influence the interpretation of data. Recent results are considered, particularly on the x-ray emission associated with flares, that have been obtained since the last review of the subject in this series. 146 references. (W.D.M.)

44106 MECHANISMS OF SOLAR FLARES. Sweet, P. A. (Univ. of Glasgow). Annu. Rev. Astron. Astrophys., 7: 149-76(1969).

Solar-flare observations, including a noncritical account of their interpretation, are discussed. A critical account is given of the current theories of the origin of flares. 89 references. (W.D.M.)

44107 CALCULATION OF THE POLARIZATION RATE FOR CONTINUOUS RADIATION. Dumont, Simone (Observatoire de Paris-Meudon, France). Compt. Rend., Ser. B, 268: 1678-81 (June 23, 1969). (In French).

The method of Feautrier is used to solve the transport equations for polarized radiation, and the rate of surface polarization is deduced from them. The theoretical results and those observed from the edge of the solar disk are compared. (tr-auth)

44108 AN AXISYMMETRIC MAGNETIC FIELD WITH DIFFERENTIAL ROTATIONS IN A SPHERICAL FLUID SHELL. II. Nakagawa, Y. (High Altitude Observatory, Boulder, Colo.). Astrophys. J., 157: 881-6(Aug. 1969).

The differential rotation in a spherical shell of an incompressible inviscid fluid of infinite electrical conductivity is examined when the magnetic field and the fluid motions are both purely toroidal. It is shown that a steady-state solution is possible, if the Alfvén velocity associated with the toroidal magnetic field is comparable with the velocity of rotation. By considering a particular set of solutions which satisfy the observed solar differential rotation on the outer surface and a constant rotation on the inner surface, it is shown that the toroidal magnetic field must be of the order of 10^4 gauss for the Sun. (auth)

44109 PHOTOELECTRIC ECLIPSE OBSERVATION OF THE CONTINUUM AT THE EXTREME SOLAR LIMB. Weart, Spencer R. (Univ. of Colorado, Boulder); Faller, James E. Astrophys. J., 157: 887-901(Aug. 1969).

The total solar eclipse of November 12, 1966, was observed with a photoelectric spectrometer. The entrance slit was placed radial to an image of the Sun and parallel to the direction of motion of the Moon's image. Light entering the slit was dispersed by a plane grating; photomultipliers observed selected spectral regions. The anode resistor of each photomultiplier was automatically switched, with the response kept linear and the signal kept at a high level for light intensities ranging over 4 orders of magnitude. At low light levels the limit of accuracy was set by photon shot noise. Limb-darkening curves for regions of the continuum 1.5 Å wide around 5278 and 6404 Å are discussed. The curves are for fairly quiet regions of the Sun near both second and third contacts. To get surface brightness from the data, the authors differentiated with respect to the position of the lunar limb, the roughness of the Moon was taken into account. On the disk, the surface-brightness results agree with those of previous investigations. But at the extreme limb the curves continue to fall with decreasing scale height (as low as 50 km) out to about 550 km above the height zero that is conventional in eclipse work (i.e., to about 800 km above the point where the radial optical depth in the continuum is unity). Here there is a sharp break in the curves, and the surface brightness falls very slowly for the next 1000 km. This break and plateau are not predicted by existing models of the Sun. It is argued that the low scale heights can be explained only if hydrogen ionization is negligible, and hence that the temperature of the atmosphere is under 5000°K out to 550 km; above, the temperature is probably over 6000°K. (auth)

44110 A CONTRIBUTION TO THE MODEL OF THE SLOWLY VARYING COMPONENT OF THE SUN DERIVED FROM OBSERVATIONS AT 8.6 MM. Feix, G. (Univ. of Bochum, Ger.). Astrophys. J., 157: 903-12(Aug. 1969).

Various authors have measured the degree of polarization of the slowly varying component of the Sun and have derived values of 20 to 30% at $\lambda = 3.2$ cm, <10% at $\lambda = 7.5$ cm, and <2% at $\lambda = 21$ cm. At $\lambda = 8.6$ mm a degree of polarization of ≈2% originating from extended plage areas was found. The observations were carried out by means of a pencil-beam antenna approximately $3.6' \times 3.1'$ in size. Measured degree of polarization is a lower limit only because of the large beam width of the antenna which averages out left-circularly polarized and right-circularly polarized components. The data obtained were analyzed in accordance with the magneto-ionic theory; an electron temperature of 8500°K was found for layers below 10,000 km. (auth)

44111 FAR-ULTRAVIOLET ABSORPTION SPECTRA WITH AUTO-IONIZED LEVELS OF BERYLLIUM AND MAGNESIUM. Mehlman-Balloffet, G.; Esteva, J. M. (CNRS, Paris). Astrophys. J., 157: 945-56(Aug. 1969).

New features in the beryllium and magnesium absorption spectra from 2000 to 500 Å are described. The observations were made using two 3-electrode vacuum sparks, one serving as a background source, the other as a source of the absorbing metallic vapor. New auto-ionized line series were identified and associated with transitions from the ground state to two-electron excitation states. Most of these resonances, owing to the interaction of the excited states with the photo-ionization continuum, present a shape which can fit into the general profile formulated by Fano's theory. (auth)

44112 MEASUREMENTS OF THE STARK BROADENING OF Hγ. Bengtson, Roger D. (Univ. of Maryland, College Park); Miller, Myron H.; Davis, W. D.; Greig, J. R. Astrophys. J.; 157: 957-61(Aug. 1969).

The Stark broadening of Hγ was investigated in three independent experiments covering the temperature range $1 \leq kT_e \leq 2$ eV and electron-density range from 2×10^{16} to 2×10^{17} cm^{-3}. Two of the experiments used a gas-driven shock tube as the spectroscopic source, while the third used an electromagnetically driven T tube. The data were reduced by fitting the experimental intensities in the lines Hβ and Hγ to the theoretical profiles of Kepple and Griem. In both cases good agreement was found between theoretical and experimental profiles from the line center down more than an order of magnitude in intensity out into the wings. The mean ratio of the electron density determined from the Hγ profile to that determined from Hβ was 1.01, with a standard deviation of ~11% and a standard deviation of the mean of ~2%. (auth)

44113 CALCULATED ELECTRON AND ION STARK BROADENING OF THE ALLOWED AND FORBIDDEN $2P - nL$ ($n \geq 5$, $L = 1, 2, \ldots, n-1$) TRIPLET AND SINGLET TRANSITIONS IN NEUTRAL HELIUM. Gieske, Harry A. (Harry Diamond Labs., Washington, D.C.); Griem, Hans R. Astrophys. J.; 157: 963-81 (Aug. 1969).

Profiles of the He I ($2^3P - 5^3D$)-line at 4026.2 Å inclusive of the forbidden components at 4045.1 Å ($2^3P - 5^3P$), 4025.5 Å ($2^3P - 5^3F$), and 4025.3 Å ($2^3P - 5^3G$), and allowing for the ($2^3P - 5^3S$)-transition at 4120.8 Å, are derived, by use of the quasi-static approximation to account for the perturbing ions and by use of the impact approximation as generalized for overlapping lines to describe the electron effects. Tabulated profiles of the line absorption coefficient are presented which, in addition to the Stark broadening of the upper levels, allow for the fine structure of the lower levels and thermal Doppler broadening. For low electron densities and higher series members (also of the singlet series), asymptotic formulas are proposed together with suitably weighted and displaced Voigt profiles. The agreement of the triplet lines with Vidal's measurement is satisfactory, except at $n \geq 10$, for which the measured profiles are narrower by more than 15%. The measured wing intensities of high-n singlet lines, however, are larger than calculated by factors of ~2. (auth)

44114 ADDITIONAL SHOCK-TUBE MEASUREMENTS OF ABSOLUTE Cr I gf-VALUES. Wolnik, S. J. (Panametrics, Inc., Waltham, Mass.); Berthel, R. O.; Carnevale, E. H.; Wares, G. W. Astrophys. J., 157: 983-95(Aug. 1969).

Absolute gf values for eighty-six Cr I lines were determined from emission of shock-heated gas mixtures. The present work is a continuation of a previous paper, which reported gf values for forty-one Cr I and two Cr II lines. Results show disagreements ranging from a few percent to factors of 10 or more when

compared with the arc values of Corliss and Bozman. The magnitude of the discrepancies appears to be dependent upon both wavelength and upper excitation potential. Comparison of the values with those of other investigators indicates that reported absolute gf values of low-excitation Cr I lines are probably accurate to within ±25%, but gf values of high-excitation lines are still uncertain by an average factor of about 4. (auth)

44115 NONTRANSFERABLE CORRELATION EFFECTS AND MULTIPLET OSCILLATOR STRENGTHS FOR ELECTRIC DIPOLE TRANSITIONS IN ATOMS WITH RESULTS ON C II, N I, N II, N III, O II, O III, O IV, F II, AND Ne II. Westhaus, Paul (Oklahoma State Univ., Stillwater); Sinanoglu, Oktay. Astrophys. J., 157: 997-1005(Aug. 1969).

Wave functions which include selected, state-dependent correlation effects are used to evaluate multiplet oscillator strengths for a number of $1s^2 2s^2 2p^n \rightarrow 1s^2 2s 2p^{n+1}$ electric dipole transitions in the first-row atoms and ions. It has long been known that those transitions cannot be accurately calculated within the restricted Hartree–Fock approximation. Results show that the usual improvement on this scheme, the mixing of those few configurations nearly degenerate with the restricted Hartree–Fock (RHF) configuration, is by itself incapable of bringing the oscillator strengths into agreement with experimental values. Additional correlation effects which show up in the open-shell many-electron theory of atomic structure (MET) developed recently by Sinanoğlu and coworkers need also be considered. Calculations including all these highly state-dependent correlation effects yield very good agreement with available experimental values. These calculated oscillator strengths, together with many more for which experimental results are not available, are tabulated. (auth)

44116 EFFECTS OF ELECTRON AND RADIATION DENSITY ON DIELECTRONIC RECOMBINATION. Burgess, Alan; Summers, Hugh P. (Cambridge Univ., Eng.). Astrophys. J., 157: 1007-21(Aug. 1969).

The statistical-equilibrium populations of excited states of He, O^{+2}, O^{+6}, Ca, Fe^{+7} and Fe^{+14} for a wide range of electron density and temperature were calculated, including the effects of dielectronic recombination as well as radiative and three-body recombination, together with collisional and radiative transitions between all states. Results are given the corresponding overall recombination coefficient, for which the name collisional–dielectronic recombination coefficient is proposed. Oxygen-ion abundance curves are given for a wide range of electron densities. They show that density effects are not very important in the outer corona, but may be appreciable in the inner corona and the chromosphere. The excited-state populations are much more strongly affected by the electron density. Very strong population inversions can arise, but Doppler shifts due to thermal motions seem to be too large for lasing to occur in the corona. This may not be the case for more massive high-temperature, low-density objects. The effects of the photospheric radiation field on coronal ions are calculated, with all transitions induced by this field taken into account. In contradiction to some earlier approximate calculations, these effects are shown to be relatively small. The form of variation of the collisional-dielectronic recombination coefficient with density and temperature can in some cases produce a tendency toward thermal instability. (auth)

44117 FORBIDDEN TRANSITIONS FOR EMISSION IN SOLAR AND STELLAR CORONAE. Mem. Soc. Roy. Sci. Liege, (5), 17: 211-46(1969).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Two review papers on emission lines and forbidden lines in coronal spectra include lists of reported lines giving wavelengths and proposed identifications. Relationships between these lines and ion abundances in the solar corona are reviewed. Two brief papers are included on two-photon processes in the solar x-ray spectrum and interpretation of intensity ratios of forbidden Fe and Ca transitions in the solar corona. (A.G.W.)

44118 SEARCH FOR SOLAR NEUTRONS USING HIGH-ENERGY PROTON-RECOIL TELESCOPES. Wolcott, John Heren, Albuquerque, N. Mex., Univ. of New Mexico, 1968. 96p.

Thesis.

A high-energy proton-recoil neutron telescope, sensitive to proton recoils from 25 to 130 MeV, was developed. A system using two of these detectors was flown to 100,000 ft, and oriented during the flight so that one detector would point toward the Sun and the other would point at the same elevation angle, but opposite in azimuth. Two successful flights were made, one of which occurred on Sept. 17, 1967, and one on Feb. 18, 1968. An upper limit of 2.8×10^{-3} neutrons cm^{-2} sec^{-1} was placed on the quiet-Sun neutron flux reaching the Earth. Three class 1 flares were observed, and an upper limit of 40 neutrons cm^{-2} was placed on the time-integrated flux from these flares. (Diss. Abstr.)

44119 ABUNDANCE OF LITHIUM IN SUNSPOTS. Traub, Wesley Arthur. Madison, Wis., Univ. of Wisconsin, 1968. 137p.

Thesis.

This study describes high-resolution, interferometric observations of the Zeeman effect of the 6708 Å lithium line as seen in sunspots. A theory of line formation is developed and applied to the observed profiles, yielding a lithium abundance which, of course, depends upon the sunspot model chosen. The derived abundance is in good agreement with that which is estimated from recent observations of the disc spectrum, provided that a sunspot model suggested by Zwaan is adopted. An isotope ratio $^6Li/^7Li$ is found. Finally, 21 lines in the neighboring sunspot spectrum are listed. It is found that the abundance A of lithium with respect to hydrogen is given by $\log A = -11.43 \pm 0.01$, (using Zwaan's sunspot model) and the isotope ratio is $^6Li/^7Li = 0.043^{+0.075}_{-0.017}$. The measured equivalent width of the lithium line is EW = 133 ± 3 mÅ. (Diss. Abstr.)

44120 TIME-DEPENDENT LUNAR ELECTRIC AND MAGNETIC FIELDS INDUCED BY A SPATIALLY VARYING INTERPLANETARY MAGNETIC FIELD. Schwartz, Kenneth (American Nucleonics Corp., Glendale, Calif.); Schubert, Gerald. J. Geophys. Res., 74: 4777-80(Sept. 1, 1969).

The response of a homogeneous conducting moon to variations and irregularities in the interplanetary magnetic field is determined. It is found that the time-dependent lunar electric and magnetic fields are forced by the oscillatory magnetic field and the oscillatory motional electric field in the solar wind plasma. In the limit of a highly conducting plasma surrounding the moon and for length scales of the interplanetary magnetic field irregularities much larger than the moon's radius, the magnetic field fluctuations in the lunar interior are the sum of the variations in the driving interplanetary magnetic field plus induced magnetic field fluctuations whose magnitude is proportional to the product of the magnitude of the interplanetary magnetic field fluctuations and the lunar magnetic Reynolds number. This induced field is toroidal about an axis in the direction of the forcing motional electric field. The zero-frequency limit of the time-dependent solution is in agreement with the steady-state induction generator solution of the interaction of the moon with a constant magnetic field. (auth)

44121 CORRELATION OF SOLAR MICROWAVE AND SOFT X-RAY RADIATION. 1. THE SOLAR CYCLE AND SLOWLY VARYING COMPONENTS. Wende, Charles D. (Univ. of Iowa, Iowa City). J. Geophys. Res., 74: 4649-60(Sept. 1, 1969).

The integral solar x-ray flux between 2 and 12 A was measured by the spacecrafts Injun 1, Injun 3, Explorer 33, and Explorer 35. The integral flux between 2 and 9 A was observed by the Mariner 5 spacecraft. The data from Injuns 1 and 3 and Explorers 33 and 35, when averaged in monthly intervals, show a long-term variation in activity of at least a factor of 5 between 1961 and 1969. A slowly varying component that tracks the 10-cm radio flux is observed in the x-ray flux. This x-ray flux variation, about a factor of 10, correlates with the appearance of major active regions on the solar disk. This slowly varying component correlates well with radio fluxes at frequencies greater than about 1 GHz and less well with radio fluxes at lower frequencies. The x-ray spectrum, obtained by comparing the 2- and 9-A flux with the 2- and 12-A flux, hardens during periods of high solar activity and may harden during flares, but it does not soften. (auth)

44122 3rd CONSULTATION ON SOLAR PHYSICS AND HYDRODYNAMICS, TATRANSKA LOMNICA, CZECHOSLOVAKIA, 13–16 OCTOBER 1964. Czechoslovak Academy of Sciences, Publication of the Astronomical Institute No. 51. Praha, Nakladatelstvi Ceskoslovenske Akademie Ved, 1965. 189p. (CONF-641030).

This publication contains all the papers read and also the important parts of the discussions. In those cases where the full text has been or will be published elsewhere, only the abstract is published. Thirty-nine papers and abstracts are included. (W.D.M.)

Galaxies

Refer also to abstract 44202.

44123 (AD-679650) RADIO SOURCES AND ELLIPTICAL GALAXIES. Report No. 1968-9. Rogstad, David H.; Ekers, Ronald D. (Owens Valley Radio Observatory, Pasadena, Calif.), 1968. Contract N00014-67-A-0094. 33p. CFSTI.

One hundred ninety-one E and SO noncluster galaxies with known

redshift were surveyed for radio emission at a frequency of 2640 MHz. The observations support the hypothesis that an elliptical galaxy must have an absolute photographic magnitude brighter than −20 to be a strong radio source. A comparison of the results of this survey with observations of radio galaxies in rich clusters indicates that cluster membership does not enhance the probability of an elliptical galaxy being a radio emitter. In addition to the strong radio sources, several E and SO galaxies were found to have weaker radio emission associated with them, but their absolute radio luminosity was still on the order of 100 times larger than that for detected spiral galaxies. (auth) (USGRDR)

44124 (AD-683358) SEARCH FOR GAMMA RADIATION FROM CENTAURUS A. Haymes, R. C.; Ellis, D. V.; Fishman, G. J.; Glenn, S. W.; Kurfess, J. D. (Rice Univ., Houston, Tex. Dept. of Space Science). Nov. 1968. Contract F44620-67-C-0062. 13p. CFSTI.

A search for radiation between 34 and 567 keV from a region in Centaurus that includes the radio galaxy Centaurus A is reported. No radiation from Centaurus A at any energy within this interval was detected and upper limits to the flux were established. (auth) (USGRDR)

44125 (N-69-22505) ORIGIN OF GALACTIC GAMMA-RAYS. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1969. 6p. (NASA-TM-X-63511; X-641-69-140). CFSTI.

A brief, critical review of the theories on gamma-ray sources is presented, and it is pointed out that neither the discrete source explanation nor the proposition that gamma rays originate in Compton collisions may be proved or disproved at the present. It is shown that the same applies to the collisional production mechanisms involving interstellar gas. From 21-cm radio observations of the Galaxy, it is found that the average value of the product of mean density and linear extension for emitting atomic hydrogen in the galactic disk, spread over the 15°-resolution cone of the OSO-3 detector, is approximately 3×10^{21} cm^{-2}. The collisional processes, however, would require a mean interstellar gas density in the disk of the order of 5 cm^{-3}, of which only 10% is observed in the 21-cm emission. Several arguments for the existence of such a mean density are also presented. (STAR)

44126 THE LARGE-SCALE DISTRIBUTION OF HYDROGEN IN THE GALAXY. Kerr, Frank J. (Univ. of Maryland, College Park). Annu. Rev. Astron. Astrophys., 7: 39-66(1969).

In the last few years it has become clear that the distribution and motion problems for hydrogen must be solved together. No attempt is made in this review to present a definitive map of the detailed hydrogen distribution, as the combined problem has not yet been solved. Progress to date is discussed and the presently known facts about hydrogen are summarized. The difficulties in the way of a full solution are outlined. 87 references. (W.D.M.)

44127 THE REDDENING, AGE DIFFERENCE, AND HELIUM ABUNDANCE OF THE GLOBULAR CLUSTERS M3, M13, M15, AND M92. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Australian National Univ., Canberra). Astrophys. J., 157: 515-31(Aug. 1969).

Reddening values of E(B − V) = 0.00, 0.03, 0.12, and 0.02 mag were obtained for M3, M13, M15, and M92, respectively, from new photometry of horizontal-branch stars via the two-color diagram. Justification for the method comes from Mihalas' calculation of I(λ) for line-blanketed stars over the relevant range of log g. The B − V main-sequence-turnoff colors agree to within 0.01 mag in all four clusters when corrections are applied for differential line blanketing. The result requires that M3 and M13, which have similar Z-values, have an age spread Δt of less than $\Delta t/t \simeq 0.03$. The same result applies separately to M15 and M92. To connect Δt for the low- and high-Z clusters requires knowledge of the turnoff temperature as a function of metal abundance. The blue-boundary colors of the RR Lyrae instability strip in M3, M15, and M92 agree to within $\Delta(B-V)_{BE}^{0.6} = 0.025$ mag when reddening and blanketing corrections are applied. The difference in mean period between the Oosterhoff–Sawyer groups cannot then be due to a temperature difference, but may arise from a difference in luminosity, as previously supposed. From Christy's models, the dependence of the blue boundary of the strip on Y, M_V, $\mathcal{M}/\mathcal{M}_\odot$, and B − V is approximated by a linear equation which reproduces Christy's Y-values to within 0.004 ± 0.018 (A.D.) over a stated parameter range. Using the assumptions in the text, a mean helium abundance of Y = 0.32 ± 0.09 (total range) is derived using $(B-V)_{BE}^{0.6} = 0.175 \pm 0.02$, $\mathcal{M}/\mathcal{M}_\odot = 0.55 \pm 0.15$, and $M_V = +0.42 \pm 0.2$. The Y-value agrees with a previous result by Christy. The helium abundances for M3, M15, and M92 are the same to within the observational error, despite the large difference in metal abundance. (auth)

44128 RADIO SOURCES AND ELLIPTICAL GALAXIES. Rogstad, D. H.; Ekers, R. D. (California Inst. of Tech., Pasadena). Astrophys. J., 157: 481-94(Aug. 1969).

One hundred ninety-one E and S0 noncluster galaxies with known redshift were surveyed for radio emission at a frequency of 2640 MHz. The observations support the hypothesis that an elliptical galaxy must have an absolute photographic magnitude brighter than −20 to be a strong radio source. A comparison of the results of this survey with observations of radio galaxies in rich clusters indicates that cluster membership does not enhance the probability that an elliptical galaxy is a radio emitter. In addition to the strong radio sources, several E and S0 galaxies were found to have weaker radio emission associated with them, but their absolute radio luminosity was still on the order of 100 times larger than that for detected spiral galaxies. (auth)

44129 LOCAL INTERSTELLAR REDDENING. Gottlieb, David M.; Upson II, Walter L. (Univ. of Maryland, College Park). Astrophys. J., 157: 611-21(Aug. 1969).

With the help of the Bright Star Catalogue, an analysis was made of interstellar reddening as a function of heliocentric distance and galactic latitude and longitude. Intrinsic B−V colors were determined for spectral types O9−K5 for each luminosity class I-V, and also for types M0−M6 for luminosity class III. Color excess was then plotted as a function of distance for 204 zones, covering the entire sky. At low galactic latitudes ($|b^{II}| \leq 10°$), an average reddening of 0.17 mag kpc^{-1} was determined. Several regions where the reddening occurred predominantly in a narrow distance range were found. At high galactic latitudes ($|b^{II}| > 20°$), color excesses were found to be <0.1 mag in nearly every direction. (auth)

44130 A SPECTROSCOPIC STUDY OF THE REMARKABLE NEBULA NGC 6302. Oliver, John P.; Aller, Lawrence H. (Univ. of California, Los Angeles). Astrophys. J., 157: 601-5 (Aug. 1969).

The remarkable nebula NGC 6302, recently discussed by Minkowski and Johnson, is found to show very high-excitation features combined with the low-excitation radiation of [O(II)] at 3727 Å. The electron density is of the order of 0.3 to 1.0×10^4 cm^{-3}, and the electron temperature is in the neighborhood of 18,000°K. Both temperature and density seem to vary from filament to filament. NGC 6302 appears to be one of the most highly excited gaseous nebulae known. The He/H ratio appears to be somewhat greater than the ratio ordinarily associated with gaseous nebulae or with the primordial value. NGC 6302 is probably not a planetary nebula, but the absence of nonthermal radio emission hints that it cannot be a supernova remnant, either. (auth)

44131 OBSERVATIONS OF AN UNUSUAL COLD CLOUD IN THE GALAXY. Riegel, Kurt W.; Jennings, Mark C. (Univ. of California, Los Angeles). Astrophys. J., 157: 563-72(Aug. 1969).

Measurements of 21-cm line spectra indicate the existence of a large cold cloud of neutral hydrogen in the Galaxy. The cloud is seen as a very strong hydrogen self-absorption feature, whose half-width is ~3.5 km sec^{-1}. An upper limit to the cloud temperature of 42°K, and a probable value of 20°K if data on continuum-source absorption are used, are derived. The cloud extends over at least 20° of longitude in the direction of the galactic center, and is probably within 1 kpc of the Sun. (auth)

44132 RESONANT WAVE PARTICLE EFFECTS AND THE ISOTROPY OF THE GALACTIC COSMIC RAY GAS. Lerche, Ian (Univ. of Chicago). pp 155-80 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

It is shown that the better than 1% isotropy of the galactic cosmic-ray gas can be understood on the basis of rapid plasma instabilities. Time scales for disturbances to e-fold once are computed and are shown to be much less than a collision period for cosmic-ray anisotropies in excess of a few per cent. (auth)

44133 FORBIDDEN-LINE EMISSION FROM THE INTERSTELLAR MEDIUM. Pottasch, S. R. (Kapteyn Astronomical Lab., Groningen, Netherlands). Mem. Soc. Roy. Sci. Liege, (5), 17: 377-87(1969).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Observations of the interstellar medium are reviewed, and possible interpretations in terms of its physical nature are considered. Ionization processes and sources of energy in the interstellar gas are discussed. The significance of recent observation of the absorption of rf radiation of frequency smaller than 15 MHz by the interstellar medium is pointed out. Tables of infrared lines that may be expected from the medium are given. Almost all the lines are forbidden magnetic dipole transitions formed by collisional

excitation from the ground state followed by radiative transition to a lower level. (A.G.W.)

44134 FORBIDDEN EMISSION LINES IN GALAXIES AND QUASARS. Osterbrock, D. E. (Univ. of Wisconsin, Madison). Mem. Soc. Roy. Sci. Liege, (5), 17: 391-403(1969).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Forbidden emission lines in the spectra of normal galaxies, radio galaxies, Seyfert galaxies, and quasars are reviewed. Possible interpretations of the lines in terms of mean densities and temperatures, ionizations, and other mechanisms are considered. It is concluded that many features of the emission spectra of normal galaxies, radio galaxies, Seyfert galaxies, and quasars seem to be qualitatively similar, differing only in degree. (45 references) (A.G.W.)

44135 LARGE-SCALE STRUCTURE OF THE NEUTRAL HYDROGEN IN THE GALAXY. Henderson, A. Peter. College Park, Md., Univ. of Maryland, 1967. 126p.

Thesis.

Recent 21-cm radio observations, taken with the 300-ft telescope at NRAO indicates a definite structure to the neutral hydrogen layer of the Galaxy as seen in the northern sky. The data for this study were in the form of scans, taken at 5° intervals in longitude from $b = +10°$ to $b = -10°$ within the longitude range $16° \leq l \leq 230°$. As expected, the central region of the Galaxy was found to be rather flat, usually within 50 pc from the standard galactic plane, and the outer region is systematically displaced above the plane defined by the inner hydrogen. This gas is in the form of a thin layer, 250 ± 50 pc thick at R_s, increasing monotonically to 500 ± 100 pc at the edge. In this layer there are density condensations forming spiral features in a trailing arm pattern of low pitch angle. These features are coherent, for they remain at a consistent height relative to the plane over large galactic distances, a z position that alternates from feature to feature. There is a pronounced low-density feature that separates the hydrogen into inner and outer regions. Beyond this "break," the hydrogen shows large systematic distortion above the plane. This distortion is measured and theoretical models are discussed. The "free precession" model and "close encounter" with the Magellanic Clouds seem to fit the data best. A noncircular component to the hydrogen velocity in the solar neighborhood is measured. This gas, located within 440 pc from the Sun, is found to have a velocity component toward the galactic center of 11 ± 3 km/sec. (Diss. Abstr.)

44136 SPECTRA OF SMALL OSCILLATIONS OF THIN DISK GALACTIC MODELS. Hunter, C. (Massachusetts Inst. of Tech., Cambridge). Stud. Appl. Math., 48: 55-76(Mar. 1969).

A survey is given of the spectral properties of the frequencies of small oscillations, both in and perpendicular to their plane, of cold thin disk galactic models. The spectra can have discrete and continuous parts, with two quite distinct types of continua arising. One type occurs with both kinds of oscillation when the density at the outer edge of the disk becomes sufficiently rarified. It is associated with rapid fluctuations in the outer region. The other type of continuum occurs for nonaxisymmetric oscillations in the plane of nonuniformly rotating disks. Some significant discrete oscillations of fundamental type are found that exist in addition to the various continua. (auth)

44137 CLUSTERING OF COLD HYDROGEN GAS ON PROTONS. Clampitt, R.; Gowland L. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature (London), 223: 815-16 (Aug. 23, 1969).

It has been suggested that the presence of ion clusters of hydrogen in gaseous nebulae could account for the absorption and polarization of stellar radiation, and that condensation of hydrogen on graphite grains at ~3°K might promote the formation of galaxies and stars. The densities of hydrogen in interstellar clouds may be great enough for ion clusters to form by interaction with radiation. Experimental work is reported showing that low-energy electron bombardment of solid hydrogen produces protons which are ejected as ion clusters of hydrogen. At the onset of condensation (on copper) protons and H_3^+ ions were observed, and as condensation proceeded ion clusters of H_2 were formed, and it appeared that protons were the primary nucleating centers of the ion clusters. In order to account for the size distribution of the ion clusters three types of interaction between protons and H_2 molecules are considered: ion induced dipole interaction; charge transfer; and three-body recombination, the latter being the most probable in the experiments described. (UK)

44138 INFRARED RADIATION FROM DUST IN SEYFERT GALAXIES. Rees, M. J.; Silk, J. I.; Werner, M. W.; Wickramasinghe, N. C. (Univ. of Cambridge, Eng.). Nature (London), 223: 788-91(Aug. 23, 1969).

It is suggested that the observed infrared radiation from Seyfert galaxies in the waveband 2.2 to 22 μm may be emitted by dust grains which absorb energy from an intense optical or ultraviolet source at the galactic nucleus. (auth) (UK)

Cosmology

Refer also to abstract 44724.

44139 DENSITY PERTURBATION AND PREFERENTIAL COORDINATE SYSTEMS IN AN EXPANDING UNIVERSE. Sakai, Kazuo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 41: 1461-9(June 1969).

Under general coordinate conditions, the equation for density perturbation in an expanding universe has fictitious solutions. In order to exclude the fictitious solutions automatically, coordinate systems moving with the average distribution of matter are adopted; and some coordinate conditions which provide for these systems are obtained. These contain not only the so-called Lagrangian gauge but also new coordinate conditions. Under these conditions, the equation for spatially periodic density perturbation becomes a second-order differential equation with respect to time and reduces to Bessel's differential equation when the equation of state is of the form $p/\ell = \text{const}$ (p = pressure, ℓ = energy density). (auth)

44140 LOW-FREQUENCY INTERGALACTIC RADIO ABSORPTION THEORY AND AN EXPERIMENTAL UPPER LIMIT. Noerdlinger, Peter D. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J., 157: 495-505(Aug. 1969).

The theoretical values for free–free intergalactic absorption at low-frequency radio wavelengths as a function of redshift z are given for a wide variety of uniform, zero-pressure cosmological models. The dependence of absorption on redshift falls well below a linear law by the time $z = 2$, except for models of large negative deceleration parameter q_0. By seeking any secular tendency of the more distant radio sources with straight spectra down to 26.3 MHz to show absorption at 10 MHz, an upper limit of 0.15 is set on the optical depth at 10 MHz and $z = 2$. This is sufficient to exclude a few low-temperature, high-density cosmological models in which the gas is kept radiatively ionized. (auth)

44141 COSMIC GAMMA-RAY SPECTRUM FROM SECONDARY-PARTICLE PRODUCTION IN THE METAGALAXY. Stecker, F. W. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: 507-514(Aug. 1969).

The form and intensity of the spectrum of cosmic γ rays resulting from the production and decay of π^0 mesons produced in metagalactic cosmic-ray p–p collisions are discussed. It is assumed that intergalactic space contains ionized hydrogen gas at a density of 10^{-5} cm^{-3}, as is consistent with recent x-ray observations at 0.25 keV. The Friedmann solution to the Einstein field equations of general relativity is used as a description of the expanding Universe, and a discussion is presented of the effects of redshift and spatial curvature on the generation and distortion of the local γ-ray spectrum from the decay of π^0 mesons. Numerical calculations are presented for the Einstein–de Sitter solution, which is found to be an adequate model for these calculations. Two models are presented to represent the possible flux of metagalactic cosmic rays. In calculating metagalactic γ-ray spectra, the effect of γ-ray absorption at large redshifts is taken into account. A discussion of the results is given. The results indicate that future γ-ray experiments in the region of 1 to 100 MeV may yield valuable information relating to cosmology, cosmogony, and the metagalactic cosmic-ray flux. In particular, the metagalactic γ-ray spectra predicted trend to peak near 70 $(1 + z_{max})^{-1}$ MeV, where z_{max}, the maximum redshift at which cosmic rays are produced, may correspond to the age of the Universe at the epoch of galaxy formation. (auth)

44142 FINITE-RANGE GRAVITATION. Freund, Peter G. O.; Maheshwari, Amar; Schonberg, Edmond (Univ. of Chicago). Astrophys. J., 157: 857-67(Aug. 1969).

The possibility that gravitation has a finite range of the order of the Hubble radius is explored. A unique Lagrangian formulation of the theory is obtained from the dynamical postulate that the symmetrical energy–momentum tensor is the source of gravitation. While locally the theory leads to extremely small deviations from Einstein's theory, the effects of finite range become decisive on the cosmological scale. In particular, general covariance and the geometrical interpretation that goes with it have to be abandoned. The field equations and equations of motion of matter are however found sufficient to answer any physical question. A pulsating cosmological solution is explicitly worked out, and the cosmological-redshift formula obtained. The theory differs from Einstein's in that it does not contain statements that are even in principle un-

verifiable experimentally, like "the graviton mass is zero," and in that it is readily quantized. (auth)

44143 PHYSICS OF MASSIVE OBJECTS. Wagoner, Robert V. (Cornell Univ., Ithaca, N. Y.). Annu. Rev. Astron. Astrophys., 7: 553-76(1969).

Massive objects are reviewed, with a view toward describing their observable characteristics. The study is restricted to coherent objects ($M \gtrsim 10^4 M_\odot$) which spend at least some time in an equilibrium state. Most of the review is concerned with the equilibrium phases of evolution, for which the most detailed calculations exist. An attempt is made to stress the features of massive objects which differ most from those of ordinary stars. One new topic covered is the properties of highly flattened, rotating, relativistic masses. 91 references. (W.D.M.)

44144 DISCRETE DISTANCES TO OUTER GALACTIC OBJECTS. Kalinkov, M.; Cholakova, N. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 119-49(1969). (In Russian).

A well-grounded verification on the effect of discretization of distances to extra galactic objects is carried out. All possible values of the red shift z, calculated by Wilson's formula, are given. The verification is carried out with the help of the quantity α_k, which must have a uniform distribution in the (0,1) interval if a discretization effect does not exist. In a case of discretization, the distribution of α_k must show a minimum in the middle of the interval (0,1). Tables and figures are given (with terraced theoretical intervals with respect to z, where the hits were observed—objects with certain red shifts as well as the distributions of the quantities α_k,) for different cases—galactic clusters, radio galaxies, quasi-stellar galaxies, and quasars. The results of the verification are as follows: (1) Wilson's conclusion for a discretization effect in the red shift of galactic clusters, particularly for the reduced theoretic table ($N \leqq 56$ and M = 2, 4, 6) is confirmed. (2) No discretization effect was observed for separate objects—galaxies and radio galaxies, probably due to the small z observed and errors in observation. (3) A discretization effect in quasars is determined with greater confidence and besides the red shifts, determined by the emission lines, exhibit a stronger effect of discretization, which confirms the cosmologic hypothesis of their nature. The discretization effect in quasars is greatest for $z > 1.4$, so that actually for z = 1.4 there exists a peculiar point in the distances to the quasars. (auth)

44145 PRIMEVAL FIREBALL TODAY. Partridge, R. B. (Princeton Univ., N. J.). Amer. Sci., 57: 37-74(Spring 1969).

Evidence that the recently discovered cosmic microwave background radiation represents the primeval fireball of the expanding universe is presented. The close agreement between the temperature (~2.7°K) derived from the absorption lines of CN molecules and the temperature measured directly by radiometers gives strong support to the theory of the microwave radiation in representing the fireball. Whether there are mechanisms other than the primeval fireball for producing background radiation in the microwave region is considered. Although several models are capable of explaining the observed spectrum (at least where it is a power law) and the large-scale isotropy of the radiation, they do not do so as economically as the primeval fireball hypothesis. Design of radiometers used to measure the background radiation and results of some measurements are considered. With the possible exception of measurements made at 0.92 cm, all radiometric measurements are consistent with the background temperature of 2.7°K. The wavelength range spanned by these measurements is greater than 200. With the measured temperatures agreeing fully, one necessary condition for the validity of the primeval fireball picture has been met. The isotropy of the cosmic microwave radiation is discussed. The existence of the cosmic microwave background casts strong doubt on the steady-state theory of the Universe. The close agreement between the observations and the primeval fireball concept argues strongly for an evolutionary model with a hot, dense beginning. The presence of thermal photons throughout the Universe could have profound effects on the passage of high-energy cosmic rays through intergalactic space. The number density of the photons, assuming a 2.7°K blackbody spectrum, is ~400 cm^{-3}, and increases as the cube of the redshift factor, $(z + 1)^3$, at earlier epochs. These photons are thus 10^9 more plentiful than electrons or protons in intergalactic space. The energy of individual photons is, of course, small (less than 10^{-3} eV). For sufficiently high-energy cosmic rays, however, collisions with microwave photons can be important. If the collision is treated in the rest frame of the cosmic ray, the thermal photon will appear as an energetic γ ray. In this frame, a number of processes are possible which reduce the energy of the cosmic ray (or destroy it entirely). Another interaction between cosmic rays and the background radiation, which is discussed, is pair production by high-energy γ rays in collision with the microwave photons. Helium production in the fireball is considered. It is concluded that important astrophysical implications may be drawn from the universal existence of thermal radiation at 3°K. Unless it is somehow shielded from the radiation, any particle in the Universe will have a minimum temperature of 3°. (BBB)

Planetary Phenomena

Refer also to abstract 44239.

44146 MAGNETOSPHERE OF JUPITER. Carr, Thomas D. (Univ. of Florida, Gainesville); Gulkis, Samuel. Annu. Rev. Astron. Astrophys., 7: 577-618(1969).

This review is concerned primarily with the observed radio emissions, the deductions from them regarding the magnetic field and the magnetosphere, and the results of theoretical investigations of interactions between the magnetic field and plasma in the Jovian magnetosphere. 153 references. (W.D.M.)

44147 FORBIDDEN TRANSITIONS OF EMISSION IN GASEOUS NEBULAE. Mem. Soc. Roy. Sci. Liege, (5), 17: 249-305(1969). (In French and English).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Papers on the following subjects are included in this section: forbidden line radiation from gaseous nebulas; collisional excitation of forbidden lines in planetary nebulas; forbidden lines in the infrared spectra of NGC 1976, IC 418, and II 4997; forbidden lines in the planetary-nebula spectra; forbidden lines and physical conditions in planetary nebulas; fine-structure transitions in neutral hydrogen clouds; physical characteristics of very young planetary nebulas and of their nuclei. (A.G.W.)

44148 STRATEGY FOR SCIENTIFIC EXPLORATION OF THE TERRESTRIAL PLANETS. Adams, John B.; Conel, James E.; Dunne, James A.; Fanale, Fraser; Holstrom, Geoffrey B.; Loomis, Alden A. (California Inst. of Tech., Pasadena). Rev. Geophys., 7: 623-61(Aug. 1969).

A strategy is presented for exploration of the inner solar system that will lead to knowledge of its origin and history. Several critical points in the evolution of the solar system are identified at which alternate evolutionary paths might have been possible. Experiments are suggested to help reveal the actual course of events at these critical points. The result is a framework relating experiments to be performed on the terrestrial planets and satellites to the major goal of determining the origin and history of the solar system. From this background, the lunar-exploration portion of the suggested over-all program is discussed in further detail. It is concluded that the Moon offers a unique opportunity for investigating certain problems of the solar system. (auth)

Atomic and Molecular Physics

44149 TABLE OF SPECTRAL LINES. Gheorghe, Pavlovschi; Traian, Tonea. Bucuresti, Redactia Revistelor Agricole, 1968. 237p. (In Rumania). (NP-17990).

The atomic spectral lines are tabulated for wavelengths from 2181.72 to 5025.58 Å to aid in spectral quantitative analysis. Basic equations for quantitative analysis are presented. (W.H.K.)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 43828 and 44521.

44150 (AD-688809) BACKDIRECTED ELECTRON YIELDS FROM METALS BOMBARDED BY 0.4-MeV TO 1.4-MeV ELECTRONS. Physical Sciences Research Papers No. 373. Frederickson, A. Robb (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Apr. 1969. 26p. (AFCRL-69-144). CFSTI.

The total backdirected electron yield due to 0.4- to 1.4-MeV electrons incident normally on aluminum, copper, and lead were measured. Retarding-potential measurements were taken to investigate the low-energy component of the backdirected flux. Careful checks were made to ensure that no error was introduced from bremsstrahlung or other external sources of electron emission. The results show that the low-energy emission is much less than previously reported and that the total emission lies between the results of Dressel (1966) and those of Wright and Trump (1962). Improvements in the design of the apparatus are described and the effects of the improvements are demonstrated. (auth) (USGRDR)

44151 (SGAE-PH-83/1969) BOMBARDMENT OF PYROLYTIC CARBON WITH NOBLE GAS IONS IN THE ENERGY RANGE

OF 10 TO 45 keV. Betz, G.; Dobrozemsky, R.; Viehboeck, F. P.; Wotke, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). [1969]. 6p. Dep. CFSTI (U. S. Sales Only).

The behavior of pyrolytic carbon under bombardment of 10- to 45-keV singly charged ions of ^{40}Ar, ^{84}Kr, and ^{132}Xe was investigated. The sputtering coefficient, the angular distribution of the sputtered material for oblique incidence in two special cases, and the coefficient for secondary electron emission have been measured. As a rather unexpected result, a preferred emission of sputtered material in the forward direction was found. (auth)

44152 STUDY OF THE RESIDUAL POLARIZATION OF NEGATIVE MUONS IN WATER AT VARIOUS TEMPERATURES AND IN HYDROCARBONS. Evseev, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR); Roganov, V. S.; Chernogorova, V. A.; Miasicheva, G. G.; Obukhov, Yu. V. pp 339-42 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

In order to check the effect of the chemical coupling or structure peculiarities of condensed matter on the value of residual muon polarization as measured by the spin precession method, the asymmetry coefficient was measured in the angular distribution of μ^- decay electrons for graphite, several hydrocarbons, and water. The asymmetry for all the hydrocarbons was $\frac{1}{3}$ to $\frac{1}{2}$ that for graphite showing that polarization is affected by chemical combinations. A sharp change was observed in passing from monomer to polymer states. A temperature dependence was noted also. (J.W.R.)

44153 MEASUREMENT OF THE ATOMIC SCATTERING FACTOR OF PLATINUM FOR 2.5- TO 50-keV ELECTRONS. Bruggraf, Charles; Goldsztaub, Stanislas (Laboratoire de Mineralogie, Strasbourg). Compt. Rend., Ser. B, 268: 1616-19 (June 23, 1969). (In French).

The results of this study show that it is possible to determine the atomic scattering factor of platinum to an absolute value of about 30% for 50-keV electrons. It is shown that for 2.5-keV electrons the idea of an atomic scattering factor preserves a physical sense although the dispersion of experimental values is very large. (J.F.P.)

44154 RANGE OF ELECTRONS WITH ENERGIES OF 0.5 TO 4 keV IN Mg, MgO, BeO, AND Al_2O_3. Bronshtein, I. M.; Brozdnichenko, A. N. (Leningrad State Pedagogical Inst.). Sov. Phys.-Solid State (Engl. Transl.), 11: 140-1(July 1969).

Translated from Fiz. Tverd. Tela, 11: 187-8(Jan. 1969).

Results of measurement of the dependence of the electron range in Mg, MgO, BeO, and Al_2O_3 on the electron energy are reported. The data were obtained by cutting off the $\eta_d(E_p)$ curves from the curve characterizing a massive layer of the coating substance (η is the inelastic reflection coefficient and d is the layer thickness). From the cutoff point of the curve for a given thickness d^*, the energy of those electrons whose maximum penetration depth is d^* and thus their maximum range can be found. (A.G.W.)

44155 TWO-FREQUENCY HYPERFINE TRANSITIONS IN ATOMIC DEUTERIUM. McCullen, J. D.; Smith, W. S.; Tipton, W. J. (Univ. of Arizona, Tucson). Phys. Rev. Lett., 23: 457-9 (Sept. 1, 1969).

A modified fast-passage transition scheme, using two frequencies, is described and discussed. (auth)

44156 CATHODE SPUTTERING OF COOLED TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS BY 70-keV $^{40}Ar^+$ IONS. Dubinskii, V. E.; Zakharova, M. I.; Lebedev, S. Ya. Sov. Phys.-Solid State (Engl. Transl.), 11: 134-5(July 1969).

Translated from Fiz. Tverd. Tela, 11: 181-3(Jan. 1969).

The angular distribution of W and Mo sputtered from single crystals bombarded by 70-keV $^{40}Ar^+$ ions and the change in the surface contour of the bombarded samples were studied. The targets were cooled by either running water or liquid nitrogen to temperatures of 290°K or 95°K respectively. A relationship between surface damage due to ion bombardment and dislocations initially present in the crystals was noted. The optical density of sputtered W deposited on cylindrical collectors is shown as a function of sputtering angle. (A.G.W.)

44157 STUDY OF THE ENERGY SPECTRUM OF SECONDARY ELECTRONS ORIGINATING ON THE PASSAGE OF ALPHA PARTICLES THROUGH THIN FILMS. Agranovich, V. M.; Daukeev, D. K.; Konobeev, Yu. V.; Lebedev, S. Ya.; Stavisskii, Yu. Ya.; Chmyrev, Yu. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 780-4(May 1969). (In Russian).

Alpha particles with an energy of 5.5 MeV were emitted from a thin layer of radioactive isotope, and knocked out secondary electrons on striking a thin, nickel film 0.1 μ thick. An electrostatic analyzer was used to obtain the energy spectrum of the emitted electrons. A sharp peak with a maximum at 1.3 eV is apparently due to Auger electrons. The contribution to the high-energy tail ($E > 8$ eV) of the distribution is supplied mainly by electrons from thermal peaks. (TTT)

44158 TEMPERATURE DEPENDENCE OF THE ION-ELECTRON EMISSION COEFFICIENT (IEEC) AND THE STRUCTURE OF THE ENERGY SPECTRUM OF THE SECONDARY ELECTRONS. Evdokimov, I. N.; Molchanov, V. A. (Kiev Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 762-4(May 1969). (In Russian).

The ion-electron emission coefficient (IEEC) was investigated as a function of ion energy, ion target incidence angle, and type of atom in the target and bombarding ions. Iron and copper targets were bombarded with 30-keV argon, neon, and krypton ions. The energy spectrum of the secondary electrons was determined on a collector consisting of two coaxial copper cylinders. The energy distribution of the secondary electrons is determined mainly by the properties of the target. This energy distribution also has a fine structure characterized by a large number of relatively narrow maxima whose positions did not depend on experimental factors such as ion current density and preliminary treatment of the target surface. Apparently the structure of the energy spectrum of secondary electrons repeats the structure of the distribution in density of electron states, as shown by a comparison of the fine structure of the x-ray absorption edges. (TTT)

44159 ION-ELECTRON EMISSION FROM ALKALI-METAL-HALIDE CRYSTALS AS A FUNCTION OF THE ANGLE OF INCIDENCE OF SLOW IONS OF THE INERT GASES. Volkov, N. F.; Kondrashev, A. I.; Petrov, N. N. (Leningrad Polytechnical Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 798-800(May 1969). (In Russian).

Single crystals of sodium chloride and potassium chloride were irradiated with helium and neon ions having energies varying from 100 to 600 eV. The ion-electron emission coefficient was determined by taking readings on an electrometer. At ion energies above 120 eV, the ion-electron coefficient is a nonmonotonic function of the incidence angle. Minimums in secondary emission are observed at angles close to the "transparent" directions in the crystal. In the low-energy region of ions the ion-electron emission does not depend on the angle of incidence. Bombardment at lower energies indicates a decrease in energy losses due to transfer of the kinetic energy of the bombarding particle to the electrons of the crystal. The absence of a dependence of the ion-emission coefficient on the angle of incidence at low energies is apparently associated with the predominance of a mechanism of exciting electrons which does not require a close approach of the colliding ion and crystal particle. The absence of a smooth rise in the ion-electron emission coefficient with increasing angle of incidence indicates that the probability of knocking out electrons in this case practically does not depend on the number of scattering centers. (TTT)

44160 He_2 MOLECULE IN A MOLECULAR BEAM. Gray, J.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Chem. Phys. Lett., 3: 523-5(July 1969).

The He_2 molecule is produced by neutralization of a He_2^+ beam in a molecular-beam apparatus. (auth)

44161 DEPENDENCE OF THE INVERSE SCATTERING COEFFICIENT FOR β RAYS ON THE TARGET ATOMIC NUMBER. Velyus, L. M.; Korzh, P. D.; Krylov, M. V.; Ignatovskii, O. M.; Dolzhenkova, L. S.; Alexandrova, M. A. (Magnetogorsk Mining Metallurgical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 134-6(1969). (In Russian).

An analysis was made of controversial published data on the mode of $\eta(Z)$ function and statistical evaluation was attempted of the hypothesis of the three modes (1) $\eta = aZ^b$, (2) $\eta = aZ^b \exp\{-cZ + dZ^2\}$, and (3) $\eta = (aZ/b + Z) \exp\{-cZ\}$. Tabulated experimental data obtained with 30 elementary targets with atomic numbers from 4 to 83 (using a point β emitter) showed that the probability of the first mode was less than 10^{-3}, while the probability of the second and the third was significantly higher. The number of degrees of freedom for the second mode was 26, for the third it was 27, indicating the latter as the most probable mode. (R.V.J.)

Atomic and Molecular Properties

Refer also to abstracts 44111-44115, 44262, 44839, and 44980.

44162 RECENT RESULTS ON L SHELL FLUORESCENCE YIELDS AND COSTER-KRONIG TRANSITION PROBABILITIES.

Rao, P. Venugopala (Emory Univ., Atlanta. Georgia Inst. of Tech., Atlanta). pp 222-33 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.
See CONF-680703-(Vol.2).

A review of recent results on L-shell fluorescence yields and Coster-Kronig transition probabilities is presented. Some improvements in experimental techniques are also described. (J.W.R.)

44163 RECENT ZEEMAN RESULTS IN ERBIUM I. Vander Sluis, K. L.; McNally, J. R. Jr. (Oak Ridge National Lab., Tenn.). J. Opt. Soc. Amer., 59: 1202-6(Sept. 1969).

Recent measurements of the Zeeman effect in Er I have resulted in a consistent set of Zeeman data, in excellent agreement with theory for the $4f^{12}6s^2$ and $4f^{11}5d6s^2$ electron configurations of Er I. The measured value of g = 1.166 ± 0.003 for the $^3H_6$ level of the $4f^{12}6s^2$ electron configuration reduces the possibility of that value differing from the theoretically predicted value or the value measured by atomic-beam methods. (auth)

44164 MANY-BODY PERTURBATION THEORY APPLIED TO MOLECULES. Kelly, H. P. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett., 23: 455-7(Sept. 1, 1969).

A method for applying many-body perturbation theory to molecules is discussed. The energy of H_2 is calculated to be -1.176 au. Results are also given for the static dipole polarizability. (auth)

44165 DYNAMIC DIPOLE POLARIZABILITY OF THE HYDROGEN ATOM. Khristenko, S. V.; Vetchinkin, S. I. Opt. Spectrosc. (USSR) (Engl. Transl.), 26: 169-70(Feb. 1969).
Translated from Opt. Spektrosk., 26: 310-13(Feb. 1969).

An asymptotic expression for the polarizability of the hydrogen atom in the ground state as a function of the frequency of the external field is found. Comparison of values obtained from this expression with numerical calculations for various values of the field indicates that the accuracy of the asymptotic expression is quite satisfactory in the region near the ionization threshold. (A.G.W.)

44166 CLASSIFICATION OF Tb II-LINES IN CONNECTION WITH HYPERFINE STRUCTURE. Meinders, E. (Univ., Amsterdam). Physica, 42: 427-38(May 15, 1969).

Wave numbers of 5000 Tb II lines were measured in the region 2850 to 3400 Å. Spacings of 550 hyperfine structure patterns were determined between 2680 and 3400 Å. An analysis based on 900 lines showing hfs yielded 10 low levels of the Tb II spectrum. Seven of these could be interpreted as the lowest levels of the even configuration $4f^85d6s$; 3 levels probably belong to the odd configuration $4f^96s$. No connection was detected between the two systems. Data are given of 10 low and 45 upper levels and of 138 classified lines. (auth)

44167 SPIN-ORBIT AND SPIN-OTHER-ORBIT INTERACTIONS FOR f^4 ELECTRON CONFIGURATION. Saxena, K. M. S.; Malli, Gulzari (Simon Fraser Univ., Burnaby, British Columbia). Can. J. Phys., 47: 1829-62(Sept. 1, 1969).

General expressions for the reduced matrix elements of spin-orbit and spin-other-orbit interactions are evaluated for all the states arising from f^4 electron configuration. These are used to calculate the Hartree-Fock values of the matrix elements of the above-mentioned interactions for $Nd(4f^4)$, $Dy(4f^{10})$, and $Ho^{3+}(4f^{10})$ atomic systems. (auth)

44168 NEW FORBIDDEN TRANSITIONS IN THE L EMISSION SPECTRUM OF Dy. Deodhar, G. B.; Varma, P. P. (Allahabad Univ., India). Physica, 43: 209-15(July 8, 1969).

The L-emission spectrum of Dy was investigated using a 40-cm bent-crystal transmission type of spectrograph. Four new lines were observed, for the first time, at λ = 1493.10, 1593.46, 1650.81, and 1700.16 XU corresponding respectively to the mixed-quadrupole transitions $L_{II}N_{III}$, $L_{III}O_{II,III}$, and $L_{III}N_{III}$ and the octupole transition $L_{II}M_V$. The investigation also confirms the existence of six transitions, namely, the transition $L_{III}M_I$ reported by Coster only, the transitions $L_{II}O_{IV}$, L_IM_{IV}, and L_IM_V seen only by Barrère, and also the transitions $L_{II}O_I$ and $L_{II}M_{III}$ observed recently only by Nigam and Garg. However, the transitions $L_{III}N_{II}$ and L_IN_I also reported by Nigam and Garg alone and the transition $L_{III}O_{IV,V}$ found by Barrère alone could not be confirmed. (auth)

44169 FORBIDDEN TRANSITIONS IN ATOMS. Mem. Soc. Roy. Sci. Liege, (5), 17: 15-117(1969). (In French and English).
From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Papers on the following subjects are included in this section: catalogs and identifications, theoretical and experimental forbidden atomic transition probabilities, excitation of forbidden lines by electron impact, excitation of forbidden lines by heavy-particle impact, two-photon and forbidden single-photon transition probabilities in helium-like ions, theoretical calculations of fine structure in highly ionized atoms, forbidden lines of the helium atom emitted in the presence of a magnetic field, broadening of He I 4471 Å and its forbidden components, forbidden lines of iron in the states from Fe^0 to Fe^{6+}, and the role of collisions in production of forbidden emission transitions. (A.G.W.)

44170 ORBIT-ORBIT INTERACTION IN f^N ELECTRON CONFIGURATIONS. Saxena, K. M. S.; Malli, G. (Simon Fraser Univ., Burnaby, British Columbia). Can. J. Phys., 47: 1885-8 (Sept. 1, 1969).

The expressions of the matrix elements of the orbit-orbit interaction for various f^N electron configurations are computed and tabulated for general usage. These expressions are used to evaluate the Hartree-Fock values of the orbit-orbit interaction in all the states for a large number of f^N electron atomic systems. (auth)

44171 SPIN-SPIN INTERACTION FOR SOME RARE-EARTH IONS. Malli, Gulzari; Saxena, K. M. S. (Simon Fraser Univ., Burnaby, British Columbia). Can. J. Phys., 47: 1397-1400 (July 1, 1969).

The spin-spin interactions are evaluated for $Pr^{3+}(4f^2)$, $Nd^{3+}(4f^3)$, $Er^{3+}(4f^{11})$, and $Tm^{3+}(4f^{12})$ using the expressions of the matrix elements of the spin-spin interaction for all the states arising from f^2 and f^3 electron configurations reported earlier. (auth)

44172 FORBIDDEN TRANSITIONS IN MOLECULES. Mem. Soc. Roy. Sci. Liege, (5), 17: 119-69(1969).
From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Papers on the following subjects are included in this section: forbidden transitions in diatomic molecules, excitation of forbidden lines by dissociative recombination, and excitation of triplet states in molecular nitrogen by low-energy electrons. (A.G.W.)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 44152, 44640, and 44966.

44173 (IS-T-311) LIFETIMES OF DEEPLY EMBEDDED POSITRONS IN METALS. Souder, Wallace William (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 146p. Dep. CFSTI.
Thesis.

Measurements of mean lifetimes of positrons deeply imbedded in metals have been made. Nuclear isotopes that emit positrons were created deep within samples by photonuclear reactions induced by the bremmstrahlung radiation of an electron synchrotron. The positron annihilation rate was shown to depend upon surface effects by measuring the lifetimes of positrons in samples of nickel in which varying percentages of annihilations occurred near the surface. The mean lifetime of positrons deeply imbedded in a large single crystal of nickel was found to be 119 ± 5 psec. The value 186 ± 6 psec was measured for positrons annihilating in the conventional sandwich sample made from two nickel single crystals. Other values obtained include: potassium with ^{39}K, $\tau_1 = 128 \pm 7$ psec, $\tau_2 = 414$ psec, $I_2 = 24\%$; molybdenum with ^{91}Mo, $\tau_1 = 152 \pm 6$ psec, $\tau_2 = 760$ psec, $I_2 = 16.2\%$, zinc with ^{63}Zn, $\tau_1 = 187 \pm 5$ psec, $I_2 \simeq 0\%$; scandium with ^{44}Sc, $\tau_1 = 217 \pm 5$ psec, $\tau_2 = 870$ psec, $I_2 = 3.9\%$; silver with ^{106}Ag, $\tau_1 = 52 \pm 5$ psec, $I_2 \simeq 0\%$; and sodium with ^{22}Na, $\tau_1 = 262 \pm 5$ psec, $I_2 \simeq 0\%$. I is intensity, τ is mean lifetime, and the subscript 2 indicates the component due to surface effects. There was no apparent agreement with any theory. A plot of λ versus r, showed no obvious trend. It was concluded that positron lifetime measurements may be meaningless unless care is taken to ensure that positrons annihilate in the interior of the metal single crystals. (auth)

44174 MEASUREMENT OF ppμ MOLECULE FORMATION RATE IN GASEOUS HYDROGEN. Budyashov, Yu. G.; Ermolov, P. F.; Konin, A. D.; Mukhin, A. I.; Oganesyan, K. O.; Zinov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). pp. 343-8 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.) Budapest, Eoetvoes Lorand Physical Society, 1968.
See CONF-680703-(Vol.3).

An NaI(Tl) scintillation counter was used to detect muonic x rays and decay electrons for negative muons stopped in gaseous hydrogen. Xenon was used as a mixing gas to reduce the number of muon decays. The rate of formation of ppμ molecules was determined from the measurements. (J.W.R.)

Collision Phenomena

44175 ROTATIONAL EXCITATION OF DIATOMIC MOLECULES BY ELECTRON IMPACT. Chang, Edward S.; Temkin, A. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev. Lett., 23: 399-403(Aug. 25, 1969)

Rotational excitation of homonuclear diatomic molecules can be simply yet accurately calculated from the scattering parameters of elastic electron–molecule scattering in the fixed-nuclei approximation. The total scattering cross sections for $\Delta j \neq 0$ transitions are independent of s-wave parameters, and ratios of $\Delta j = \pm 2$ cross sections agree with experimental results in H_2 and with rotational close-coupling calculations. Absolute total and differential cross sections can be explained. (auth)

44176 ELASTIC SCATTERING OF POTASSIUM IONS IN THE ENERGY RANGE 150 TO 4000 eV WITH ARGON. Amdur, I.; Inouye, H.; Boerboom, A. J. H.; van der Steege, A. N.; Los, J.; Klatemaker, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 41: 566-74(Mar. 27, 1969).

The incomplete integral cross section of the elastic scattering of K^+ ions by Ar atoms was determined in the energy range from 150 through 4000 eV by passing a well defined beam of K^+ through a collision chamber filled with Ar gas at room temperature. The pressure of the gas was about 7×10^{-3} torr. The results can be represented by the inverse power potential (K/r^s), however, with K and s functions of the internuclear separation. The exponential potential ($A \exp - \alpha r$) gives a good representation over almost the whole energy range with a single set of parameters: A = 4400 eV, $\alpha = -3.95$ Å^{-1}. The cross section was compared with that of the isoelectronic system of fast Ar atoms in the same energy range colliding with thermal Ar atoms. A reduction of 10% was found in the diameter of the electron cloud in going from Ar to K^+. At the energies of 1000, 2000, and 4000 eV the cross section for $^{41}K^+$ was measured and it was found to be equal to the values for $^{39}K^+$ within experimental error. (auth)

44177 EXCITATION OF Ne, Ar, Kr, AND Xe BY He^+ IMPACT (0.3 TO 10 keV). de Heer, F. J.; Luyken, B. F. J.; Jaecks, D.; Wolterbeek Muller, L. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 41: 588-600(Mar. 27, 1969).

Impact radiation from He^+ in Ne, Ar, Kr and Xe is studied in the wavelength region between 500 and 2000 Å. This work forms a continuation of the measurements between 3000 and 6000 Å, published in a preceding article. There the relatively strong production of spectral ion lines of the target atom, whose emission cross sections in many cases show a striking increase with decrease in impact energy, was discussed. The deviation from the normal adiabatic behavior in the lower energy range was explained by the effect of pseudocrossing of the potential curves of the collision complexes before and after the reaction. In the present experiment the same behavior is found for many ion spectral lines in the vacuum ultraviolet region. The experimental results indicate that the upper levels of these spectral lines are populated not only by the collision process, but for a large part via cascade from higher excited ion levels formed in the collision process. There is strong evidence that in the low-energy region (~300 eV) most of the electron capture processes go in combination with the formation of the excited ion states of the target atom, considered in this article. Further it is found that the deviation from the normal adiabatic behavior is not only confined to the emission of the ion spectral lines, but also occurs for atomic spectral lines of the target atom. (auth)

44178 HYDROGEN-ATOM SCATTERING: VELOCITY DEPENDENCE OF TOTAL COLLISION CROSS SECTIONS FOR RARE GASES AND MOLECULAR HYDROGEN. Stwalley, W. C.; Niehaus, A.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 51: 2287-8(Sept. 1, 1969).

Total cross sections for scattering of hydrogen atoms by Kr, Xe, and H_2 at 0.1 to 1 eV are presented. The results confirm and extend data previously obtained at 0.05 to 0.5 eV. The points obtained at higher velocities indicate that Xe belongs to the transition realm between those realms in which attractive or repulsive forces are dominant. (A.G.W.)

44179 ATOMIC AND MOLECULAR SCATTERING FROM SOLIDS. II. COMPARISON OF CLASSICAL SCATTERING MODELS IN RELATION TO EXPERIMENT. McClure, J. Doyle (Boeing Scientific Research Labs., Seattle). J. Chem. Phys., 51: 1687-1700(Sept. 1, 1969).

Characteristics of a classical two-dimensional (2D) model of atomic scattering from finite-temperature, elastic solids are compared to similar characteristics of "quasi-1D" scattering models in light of pertinent experimental scattering studies of rare-gas atomic beams on metals. (The term "quasi-1D" is used to denote scattering models based on the assumption that tangential interaction is negligible, i.e., dynamical interaction is presumed to occur only in the direction normal to the local surface plane.) The 2D finite-range interaction field (denoted 2D FRI) is composed of additive Lennard–Jones (12,6) pairwise potentials. Compared scattering characteristics include beam directivity and position as well as variation of mean tangential/normal momentum with scattering angle. It is shown that combined "structure" and "thermal" broadening associated with 2D FRI can account for systematic differences between experimentally observed lobe directivity and that predicted by quasi-1D "soft/hard cube" scattering models. For nongrazing incidence, strong angular variation of tangential momentum over the high-intensity portion of the scattered beams, as predicted by the 2D FRI model, is also in qualitative agreement with experiment. Dominant effects of finite "collision time," as determined by 2D FRI, cast doubt on previous interpretation that observed differences in lobe position for effusive incident beams of different rare gases scattered from a particular hot metal crystal result from simple mass ratio effects. Effects of finite "collision time" are also invoked to interpret recent experimental findings on differences in lobe position for a given rare-gas beam scattered from different hot metal crystals. It is concluded that quantitative theoretical studies of gas–surface scattering must await development of tractable 3D FRI models. (auth)

44180 MULITIPLE IONIZATION OF He, Ne, AND Ar BY 2 TO 16 keV ELECTRONS. van der Wiel, M. J.; El-Sherbini, Th. M.; Vriens, L. (FOM-Instituut vor Atoom- en Molecuulfysica, Amsterdam). Physica, 42: 411-20(May 15, 1969).

Relative abundances of multiply charged ions formed by electron impact (2 to 16 keV) on some noble gases were measured using a charge analyzer with 100% transmission. Large discrepancies exist between the values and those obtained in low-transmission mass spectrometers. Cross sections were determined by normalization of the absolute gross ionization cross sections of Schram et al. The measured proportionality constants of the E_{ei}^{-1} in E_{ei} term in the cross section are compared with those obtained from an analysis of photoionization data. The agreement is good if the multiple-electron ejection from the outer shell is taken into account in addition to one-electron ejection from an inner shell. (auth)

44181 ELECTRON-IMPACT EXCITATION FUNCTIONS FOR METASTABLE STATES OF N_2. Freund, Robert S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 51: 1979-82(Sept. 1, 1969).

The metastable excitation function for N_2 is mainly due to the $A\ ^3\Sigma_u^+$, $E\ ^3\Sigma_g^+$, and a $^1\Pi_g$ states. This interpretation, which is based on (1) the optical-excitation functions for these states, (2) their radiative lifetimes, and (3) new measurements of the metastable excitation function at a range of times after excitation, is consistent with other workers' data. The roles of several other metastable states of N_2 are also discussed. (auth)

44182 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS BY THE HYDROGEN MOLECULE. Tully, John C.; Berry, R. Stephen (Univ. of Chicago). J. Chem. Phys., 51: 2056-75(Sept. 1, 1969).

Electron–H_2 scattering at low energies is treated by an efficient numerical solution of the two-dimensional Schrödinger equation including the nonlocal exchange interaction. Correlation within the scatterer is included but polarization and short-range free–bound correlation are omitted. The elastic differential cross section is well described for scattering angles larger than about 30° to 45°, and for energies up to at least 5 eV. The scattering function is analyzed in terms of spherical harmonics; the expansion is slowly convergent in the region 0.6 to 1 Bohr radii with significant contributions as high as l = 10. The position of the observed broad resonance at about 3 eV is accounted for by the model in terms of the p_0 wave, but it is inferred that free–bound correlation is necessary to account quantitatively for the width. (auth)

44183 ENERGY DEPENDENCE OF THE ELASTIC TOTAL COLLISION CROSS SECTION OF IDENTICAL MOLECULES OF ^{4}He. Dondi, M. G. (Univ., Genoa); Scoles, G.; Torello, F.; Pauly, H. J. Chem. Phys., 51: 392-7(July 1, 1969).

The velocity dependence of the total collision cross section for velocity-selected molecular beams of ^{4}He scattered by ^{4}He at 2°K was measured. Undulations due to the quantum statistics were resolved between 650 and 1200 m sec^{-1}. Results are compared with exact and approximate calculations, and the sensitivity of this effect to potential parameters is discussed. Finally the possibility of extracting from the data the absolute value of the total collision cross section without using gas-density measurements is shown. (auth)

44184 ENERGY SURFACE AND GENERALIZED OSCILLATOR STRENGTH OF THE $^1A''$ RYDBERG STATE OF H_2O. Miller, K. J. (Rensselaer Polytechnic Inst., Troy, N. Y.); Mielczarek, S. R.; Krauss, M. Contract AT(49-2)-1165. J. Chem. Phys., 51: 26-32(July 1, 1969).

The energies and wave functions of the lowest singlet and triplet Rydberg states in H_2O were calculated in the expansion basis self-consistent-field procedure for a single configuration. A portion of the energy surface of the $^1A''$ Rydberg state for an HOH angle of 105° was determined that shows the asymmetric dissociation of this state into ground-state $H(^2S)$ and $OH(^2\Pi)$ fragments. The energy along the reaction coordinate is almost separable into a repulsion depending only on the center-of-mass separation and an attractive potential that depends only on the OH internuclear separation. For the C_{2v} conformation a large basis set was used to approach the Hartree–Fock limit. These functions were used to calculate a minimum in the generalized oscillator strength for the $^1A_1 \rightarrow {}^1B_1$ transition as a function of the momentum transfer function or the electron scattering angle. This behavior was then confirmed experimentally for an energy loss of 7.4 eV with an incident electron energy of 500 eV. Such a minimum is a general characteristic of Rydberg transitions and is not an essentially molecular phenomena. The good agreement between experiment and theory indicates a reasonable fit to the Rydberg wave function by the approximate Hartree–Fock calculation. (auth)

Atomic Theory

44185 EFFECTS OF ATOMIC INTERACTIONS ON THE ABSORPTION AND EMISSION OF RADIATION. Hearn, Dwight D. (Univ. of Utah, Salt Lake City); Fontana, Peter R. Contract AT(11-1)-1112. J. Chem. Phys., 51: 1871-80(Sept. 1, 1969).

The processes of absorption and emission of radiation by a system of two interacting atoms is investigated. Separation between the atoms is assumed to be much larger than the atomic diameter, and interactions considered are those between the individual atoms and the radiation field and the electrostatic interaction between the atoms. Calculations include those for the time-dependent probability amplitude of the intermediate and final states as well as that of the emission line shape. The line shape of the emitted radiation consists of two peaks whose amplitude, separation, and half-width are functions of both the internuclear separation R of the atoms and the energy difference of the excited states of the two atoms. For a large energy difference, the peaks are distinct; for small energy differences, the peaks are distinct at smaller separations, but merge toward the line shape characteristic of a single, isolated atom as R increases. (auth)

44186 RELATIVISTIC AND CORRELATION EFFECTS FOR OPTICAL LEVELS OF LARGE ATOMIC SYSTEMS: APPLICATION TO Tl II. Beck, Donald R. (Lehigh Univ., Bethlehem, Pa.). Contract AT(30-1)-3408. J. Chem. Phys., 51: 2171-83 (Sept. 1, 1969).

The effects of relativity and correlation on bound levels of large atomic systems are investigated by using the low-Z Pauli approximation for the Hamiltonian. A linear combination of Slater determinants is used to approximate the wave functions. The radials are obtained from the Hartree–Fock–Slater equation with six potential forms, and the coefficients are found by application of the variational principle. Results are obtained for a matrix element involving any two configurations composed of a closed core and two valence spin orbitals. Application is then made to some of the bound levels of Tl II. The average error in the energy levels (the ground state is the reference level) is found to be 5% as compared to the average error of 25% in the nonrelativistic results of Beck. Both correlation and relativistic effects are important. (auth)

44187 HARTREE–FOCK ATOMIC PARAMETERS. Fraga, Serafin; Thorhallsson, Jon; Fisk, Carolyn (Univ. of Alberta, Edmonton). Can. J. Phys., 47: 1415-18(July 1, 1969).

A comprehensive calculation of the parameters involved in energy interactions (dipole polarizabilities, magnetic susceptibility, nuclear magnetic shielding, quadrupole coupling constant, magnetic hyperfine structure constant, Fermi contact interaction constant, octopole coupling constant, orbit–orbit interaction, spin–orbit coupling constant, spin–spin coupling constant, and spin–spin contact interaction) in many-electron atoms has been carried out. The corresponding results, together with the values available in the literature, have been compiled in a technical report for the ground states and some excited states of the negative ions, neutral atoms, and the first four positive ions from He to Kr. An example of the prediction of atomic energy levels, using these values, is presented. (auth)

44188 PERMUTATION DEGENERACY IN THE PRESENCE OF LARGE SPIN–ORBIT COUPLING. Levy, Peter M. (Yale Univ., New Haven). Chem. Phys. Lett., 3: 556-9(July 1969).

Some interesting features of the extension of the Heisenberg–Dirac–Van Vleck exchange Hamiltonian to systems of electrons with orbital degeneracy and large spin–orbit coupling are discussed. (auth)

Cosmic Radiation

Refer also to abstracts 43528, 44125, 44141, and 44621.

44189 (AD-682341) THE STUDY OF THE COSMIC RAY INTENSITY VARIATIONS OBSERVED AT MT. CHACALTAYA DURING 1965–1967. PART II. Final Technical Report. Ahluwalia, H. S. (Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica). Jan. 31, 1968. 34p. (AFOSR-69-275-TR). CFSTI.

Super neutron monitor and pressure data obtained at Mt Chacaltaya during the period July 1967 to June 1968 are presented. Graphical representation of the corrected super neutron monitor data obtained at Mt. Chacaltaya during the period July 1967 to June 1968 is also included. (USGRDR)

44190 (AD-682342) THE STUDY OF THE COSMIC RAY INTENSITY VARIATIONS OBSERVED AT MT. CHACALTAYA DURING 1965–1967. PART III. Final Technical Report. Ahluwalia, H. S. (Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica). Jan. 31, 1968. 60p. (AFOSR-69-276-TR). CFSTI.

The report contains radiosonde data obtained at Ovejuyo during the period November 1967 to December 1968. (auth) (USGRDR)

44191 (AD-688237) BASJE CHERENKOV LIGHT EXPERIMENT. Final Report. Bradt, Hale V.; Krieger, Allen S.; Rappaport, Saul A. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). May 14, 1969. Contract F44620-67-C-0020. 37p. (AFOSR-69-1319-TR). CFSTI.

The experiment was designed to measure the characteristics of the Cherenkov light in extensive air showers, and to derive information about the primary composition. The research indicates that the chemical composition of primary cosmic rays up to 10^{16} eV is mixed much as it is at lower energies, approximately 10^{12} eV. (USGRDR)

44192 (N-69-15944) [RADIATION MEASUREMENT OF RADIOBIOLOGICAL HAZARDS OF MEN IN SPACE]. Annual Report, October 1, 1967–September 30, 1968. Baily, Norman A. (Emory Univ., Atlanta, Ga.). Sept. 30, 1968. 99p. (NASA-CR-99036). CFSTI.

Experiments were conducted to test the Blunch–Leisegang theory of the statistical distributions of small energy losses for path lengths corresponding to those of biological interest. Preliminary results were obtained at 600 MeV. The Blunch–Leisegang correction was applied to the Vavilov distribution of energy losses in order to compare experimental data with a theoretical curve. The comparison shows some discrepancies between theory and experiment out in the high-energy tail regions of the distributions. Several possible reasons for this discrepancy are examined. Consideration is also given to experimental pulse-height spectra distortions due to the effect of pulse pile-up. It is concluded that the predictions of the pile-up magnitude and the shape of the distorted spectrum are reasonable, and that these methods may be used to evaluate the effects of pile-up on experimental proton energy deposition spectra. Data outlines are included on the results of either animal or cellular radiation studies using protons as the source of incident radiation. (STAR)

44193 (N-69-22324) ON THE RATE OF FORMATION OF NEUTRONS UNDER THE ACTION OF COSMIC RADIATION NEAR THE EARTH'S SURFACE. Gorshkov, G. V.; (and others). Translated from At. Energ. (USSR), 26: 27-30(1969). 10p. (NASA-CR-100528). CFSTI.

An investigation was conducted on the transient effect below the atmosphere–water interface and the latitude and altitude dependences near the ground to determine the background of natural neutrons due to cosmic radiation near the Earth's surface. This information is considered for possible applications in prospecting for economic mineral deposits. Instrumentation utilized in the investigation is described. (auth) (STAR)

44194 (N-69-22887) INTERACTION OF COSMIC PROTONS WITH INTERPLANETARY PLASMA. Nikolayev, Yu. M. Translated from Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 113-16(1969). 27p. (NASA-CR-100530). CFSTI.

Considerations are given for the energy losses of a nonrelativis-

tic proton beam to the excitation of longitudinal electrostatic oscillations of interplanetary plasma. Linear approximations and distribution functions are derived to solve for the energy losses. (STAR)

44195 (N-69-22966) COMPARATIVE EVALUATION OF THE RADIATION ENVIRONMENT IN THE BIOSPHERE AND IN SPACE. Schaefer, Hermann J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Dec. 13, 1968. 20p. (NASA-CR-100647; NAMI-1054). CFSTI.

The natural level of background radiation in the biosphere ranges from a lowest value of 6 microrem/hr over the ocean to values more than 300 times higher than are found in small inhabited areas in Brazil and India. These highest radiation levels in the biosphere overlap the lowest in space as long as only regions outside the radiation belt and conditions of a quiet Sun are considered. Since shelters for solar proton storms on the moon or planets could be built, utilizing indigenous rock, man's long-term survival in space appears to be assured as far as ionizing radiation is concerned. The inconspicuous chronic damage, such as shortening of the life span, that would result from galactic radiation exposure in space is difficult to assess quantitatively. Extrapolating data on radiation-induced life shortening with gamma rays and neutrons for the mouse, one arrives at a figure of 25% for the life-shortening effect of galactic radiation exposure in space. As far as acute effects from trapped or flare-produced protons are concerned, the most acute problem operationally is the treatment and alleviation of discomfort from skin erythema, and possibly more severe skin damage, resulting from medium-high doses which would leave more deeply seated tissues and organs essentially intact because of the much lower depth doses of these peculiar radiations. (auth) (STAR)

44196 (N-69-23198) NUCLEAR EMULSION MEASUREMENTS OF THE ASTRONAUTS' RADIATION EXPOSURE ON APOLLO 7. Schaefer, Herman J.; Sullivan, Jeremiah J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Feb. 13, 1969. 15p. (NASA-CR-100645; NAMI-1060). CFSTI.

Preliminary results are presented in order to establish a comparative base line for radiation exposure of astronauts in conventional near-earth satellite orbits with the deep space trajectories of later Apollo flights. Such a comparison is of particular interest due to the fact that the Apollo mission made only two very rapid passes through more peripheral regions of the inner radiation belt and avoided the repeated traversals of the South Atlantic anomaly, which accounted for more than 90% of the dose on all Gemini flights. In addition, the Apollo trajectory was nearly outside the magnetosphere, allowing exposure to the full galactic flux with no geomagnetic cutoff, at 4 pi incidence on the ship for most of the mission. Track and grain count analysis of only one of the three G.5 emulsion packs furnished a dose of 122 mrad; the LET distribution was nearly identical to one recorded by Gemini 7. Proton ender counts in all packs showed more uniformity in directional distribution than those on Gemini 7, presumably caused by heavier shielding. (STAR)

44197 (N-69-29750) COSMIC GAMMA-RAY SPECTRUM FROM SECONDARY PARTICLE PRODUCTION IN COSMIC-RAY INTERACTIONS. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1969. 26p. (NASA-TM-X-63581; X-641-69-238). CFSTI.

The cosmic gamma-ray spectrum below 1 GeV, arising from cosmic-ray p-p interactions, is calculated. Its properties are determined by the properties of secondary π^0 production occurring at accelerator energies. An isobar-plus-fireball model is chosen for numerical calculations in which the two dominant modes of π^0 production at accelerator energies are the production of the $\Delta(1238)$ isobar and one fireball. Each of these modes of production then yields a component to the total γ-ray spectrum. The affect of α-p and p-α interactions on the cosmic gamma-ray spectrum is also calculated. The components are summed, and the results are given in terms of both differential and integral gamma-ray energy spectra. (auth) (STAR)

44198 (N-69-29942) REEXAMINATION OF THE ANOMALOUS ZENITHAL DISTRIBUTION OF THE ATMOSPHERIC MUONS. Maeda, Kaichi (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1969. 11p. (NASA-TM-X-63579; X-640-69-222). CFSTI.

An examination of the data from the Utah neutrino detector indicates the presence of internal inconsistencies. This is shown by making comparisons among in situ data only, instead of referring them to the world survey data. The X-process seems, therefore, weakly based, if not unsubstantiated. (auth) (STAR)

44199 COSMIC BACKGROUND X-RAYS PRODUCED BY INTERGALACTIC INNERBREMSSTRAHLUNG. Hayakawa, Satio (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1592-4(June 1969).

It has been suggested previously (Hayakawa 1968) that the observed intensity of the diffuse component of cosmic x rays can be accounted for in terms of inner bremsstrahlung produced by the collisions of intergalactic cosmic rays with electrons. This mechanism is incorporated with the heating of the intergalactic medium as advocated by Ginzburg and Ozernoi (1966). It is shown that the energy spectrum of the background component of x rays can also be explained by the same mechanism. (W.D.M.)

44200 COSMIC RAYS IN THE GALAXY. Meyer, Peter (Univ. of Chicago). Annu. Rev. Astron. Astrophys., 7: 1-38(1969).

The present state of knowledge of the primary cosmic radiation is summarized and some aspects considered to be most relevant to general problems of galactic physics are highlighted, without paying attention to historical developments. After a discussion on the extrapolation of the cosmic radiation to interstellar space, the experimental facts are summarized and some of the implications and conclusions are considered. 159 references. (W.D.M.)

44201 COSMIC X-RAY BREMSSTRAHLUNG ASSOCIATED WITH SUPRATHERMAL PROTONS. Boldt, Elihu; Serlemitsos, Peter (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 157: 557-62(Aug. 1969).

Copious x-ray production is shown to attend the collisions of suprathermal ($\geq$ MeV) protons with ambient electrons. Such suprathermal protons have been detected in association with solar-flare events and cosmic rays. The x-ray emission to be expected for the well-observed solar-proton event of September 28, 1961, agrees with measurements. It is demonstrated that suprathermal cosmic-ray protons propagating through the interstellar gas could be responsible for a detectable component of the diffuse sky background of x rays. The possible role of suprathermal protons in producing the x rays emitted by the Crab Nebula is examined and found to be inconclusive. (auth)

44202 THE PROPAGATION AND ANISOTROPY OF COSMIC RAYS. II. ELECTRONS. Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 157: 545-55(Aug. 1969).

Synchrotron radiation makes cosmic-ray electrons anisotropic. The electrons' distribution function in pitch angle was evaluated, in case the electrons steadily create — and are scattered by — hydromagnetic waves in an ionized plasma. It was found that the radiation from radio galaxies is generated by nearly isotropic electrons. In our Galaxy, the anisotropy increases with energy and is 1% at ~10^2 GeV. However, the scattering of cosmic-ray electrons in the galactic disk is dominated by waves from other poorly known sources, primarily the streaming of cosmic-ray protons. (auth)

44203 RADIO WAVE EMISSION FROM EXTENSIVE AIR SHOWERS. Nishimura, Jun; Fujii, Masami (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 476-93(July 1969). (In Japanese).

Many mechanisms on the radio wave emission from an extensive air shower have been proposed. Among them the mechanisms due to Cerenkov radiation seem to be most promising, and effects due to annihilation of positrons, Compton electrons, knock-on electrons and geomagnetic deflection are critically examined on the bases of three-dimensional cascade shower theory. The interference effect of the radio wave due to the spatial distribution of each process as well as the curvature of the shower front are found to be important to the emissivity of radio wave and the effect depends on the frequency of the radio wave. Therefore the degree of polarization of radio waves essentially depends on the frequency of observed radio waves. Experimental results for the relation of polarization vs radio frequency seem to be understandable by this theory. (NSA of Japan)

44204 INFLUENCE OF THE METEOROLOGICAL EFFECTS ON THE AVERAGE DIURNAL VARIATIONS OF THE NEUTRON COMPONENT OF THE COSMIC RADIATION. Akhababyan, N.; Stamenov, I. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 59-64 (1969). (In Russian).

The influence of the meteorological effects on the average diurnal variations of the registered component was investigated on the basis of the continuous registration of the neutron component of the cosmic radiation for the period August 1964 to August 1965 with a standard neutron monitor in the Cosmic Station on the Musala peak. Corrections are introduced for the barometric effect as well as for the temperature effect, obtained on the basis of the correlation equation $\delta N = a_1\delta p + \beta_2\delta T_M$, where δT_M is the average daily change of temperature at the point of measurement. Fourier analysis was employed for the successive determination of the amplitudes and phases of the first and second harmonics of the average daily variations for the uncorrected, the corrected

for the barometric effect, and the corrected for the barometric and temperature effect data. The results obtained show that while the amplitude of the first harmonics of the average daily variations of the uncorrected data is about 0.30% with a maximum during the hours of the night and the introduction of the barometric corrections decreases the amplitude almost twice without changing the phase substantially, the introduction of the temperature corrections as well restores approximately the original amplitude and the phases are shifted in the early afternoon hours. The amplitudes of the second harmonics are always equal to about half of the first harmonics and, as is the case with the phases, are not dependent on the introduction of meteorological corrections. (auth)

44205 FLUX AND ENERGY SPECTRUM OF COSMIC-RAY ELECTRONS AT A GEOMAGNETIC RIGIDITY OF 4.5 GeV. Oran, William Alexander. Cleveland, Case Western Reserve Univ., 1968. 115p.

Thesis.

The flux and energy spectrum of cosmic electrons were investigated at 41° geomagnetic north using balloon flights at two different altitudes. An 18 gap glass–metal spark chamber consisting of a thin plate section to observe the track of the initiating particle and a section consisting of 7.7 radiation lengths of lead to observe the interaction of the particle was used to view the showers created by the high-energy electrons. To greatly improve the multiple sparking efficiency, 0.01" thick glass sheets were placed on either side of and in contact with the anode plates in order to limit the current available to the individual sparks. The chamber was triggered by a detector system consisting of a gas Cherenkov counter sandwiched between two plastic scintillators. The system was calibrated with electrons in the energy range of 1 to 6 BeV at the C.E.A. The results of this calibration were used to determine the energy of the electrons seen on the flights. The flux below 3 BeV appears to be dependent on altitude while the flux above 3 BeV appears to be independent of altitude. In fact, the fluxes in the energy range of 1 to 2 BeV (.90 ± .56 and 2.05 ± .76 [m² sec sr BeV]$^{-1}$) agree with the theoretical calculations of the secondary electrons produced in the atmosphere. Results above 4 BeV essentially agree with the results of other groups and the differential flux can be described by the $dN/dE = (95 \pm 30)E^{-2.4\pm.3}$ (m² sr sec BeV)$^{-1}$. From the data, the integral flux above 4 BeV is 2.78 ± .87 electrons/(m² sec sr) giving an electron–proton ratio of .004 ± .001. The proton flux was monitored periodically throughout the flights. It remained constant to within statistical uncertainties and was equal to 603 ± 60 particles/(m² sec sr), thus indicating that the system functioned properly at altitude. (Diss. Abstr.)

44206 ESTIMATE OF RE-ENTRANT ALBEDO FLUX OVER HYDERABAD FROM THE OBSERVED DIRECTIONAL ASYMMETRIES. Gokhale, G. S.; Kunte, P. K.; Sundararajan, R. (Tata Inst. of Fundamental Research, Bombay). J. Geophys. Res., 74: 4781-6(Sept. 1, 1969).

Results on the observed east–west asymmetry over Hyderabad (λ = 8°N geomagnetic) during IQSY with an oriented telescope inclined at 40° to the vertical at an atmospheric depth of 6.7 g/cm² are reported. The observed asymmetry for singly charged particles is about two-thirds of the expected one on the basis of proton primaries with an integral energy spectrum of the form $N(>E) = K \cdot (I + E)^{-1.5}$. The re-entrant albedo flux at the top of the atmosphere estimated from the observed asymmetry is 25 ± 9 particles/m² ster sec. (auth)

44207 FLUX AND SPECTRUM OF PRIMARY HYDROGEN NUCLEI NEAR GEOMAGNETIC EQUATOR. Puri, R. K.; Aditya, P. K. (Indian Inst. of Tech., Delhi). J. Geophys. Res., 74: 4787-90(Sept. 1, 1969).

In an emulsion stack exposed at an atmospheric depth of 3.8 g cm^{-2} on March 16, 1965, the flux of primary hydrogen nuclei was estimated equal to (103 ± 11) particles/m² ster sec, corresponding to a threshold rigidity of 16.8 GV. The regression curve for the integral flux of primary hydrogen nuclei above 16.8 GV versus neutron monitor count rate was drawn. The ratio of primary hydrogen to helium nuclei measured simultaneously at the same location yields a value of 7.2 ± 1.0. The integral rigidity spectrum of primary hydrogen nuclei can be represented by a spectral index of –(1.65 ± 0.12). (auth)

44208 INCREASE IN COSMIC-RAY CUTOFFS AT HIGH LATITUDES DURING MAGNETOSPHERIC SUBSTORMS. Barcus, J. R. (Univ. of Denver). J. Geophys. Res., 74: 4694-4700 (Sept. 1, 1969).

Balloon observations obtained at Byrd Station, Antarctica (L ≈ 7), are presented of time variations in the nuclear γ-ray flux produced by proton bombardment of the terrestrial atmosphere during the January 28 and February 2, 1967 solar proton events. The observations reveal evidence for transient increases in the proton cutoff during the local evening and morning hours, and these changes are associated with the occurrence of modest magnetospheric substorms. The increase in the cutoff as observed near earth is delayed by some 10 to 15 minutes from the first appearance of Pi-2 micropulsations. Assuming entry of low-energy solar protons (1 to 30 MeV) occurs through the magnetotail, the observed delay (mostly of a hydromagnetic origin) suggests that the effective region of entry is located at least 10^2 R_E downstream. Once the cutoff started to increase, an additional 5 to 10 minutes were required for the full effect to take place. It is suggested that the observed delay is the time required for a substantial portion of tail field to collapse toward earth. The cutoff recovered within about an hour, a time scale characteristic of magnetospheric substorm duration, and it is further suggested that this is approximately the time required to re-establish the magnetotail to its former state. (auth)

44209 COSMIC-RAY ELECTRONS BETWEEN 12 MeV AND 1 Gev in 1967. Israel, Martin H. (California Inst. of Tech., Pasadena). J. Geophys. Res., 74: 4701-13(Sept. 1, 1969).

Observations of cosmic-ray electrons in the energy range of 12 MeV to 1 GeV were made in 1967 in a series of high-altitude balloon flights with a detector consisting of a scintillation-counter telescope, gas Cherenkov counter, and lead-plate spark chamber. Three flights were launched from Fort Churchill, Manitoba, in the summer of 1967, to measure the vertically incident primary electron flux; a fourth flight gave a direct measurement of splash albedo electrons. In April 1967 return albedo electrons were observed on a flight launched from Palestine, Texas. 2σ upper limits are derived for the flux of primary electrons at the top of the atmosphere of 20, 9, and 13 electrons/m² sec ster in the energy intervals 17 to 57, 57 to 112, and 112 to 374 MeV respectively. Between 374 and 1060 MeV one finds 16 ± 14 electrons/m² sec ster. Above 100 MeV these results lie significantly below fluxes reported for 1966 by other observers. Comparison between the observed upper limits to the primary flux and a calculation of the flux of galactic secondary electrons indicates an absolute solar modulation of electrons below 300 MeV by at least a factor of 3. One observed splash albedo fluxes of 94 ± 16, 47 ± 11, 27 ± 9, and $2^{+1}_{-0.5}$ electrons/m² sec ster in the energy intervals 12 to 50, 50 to 100, 100 to 350, and 350 to 1000 MeV, respectively, near Fort Churchill, Manitoba. Near Palestine, Texas, we find 60 ± 26 return albedo electrons/m² sec ster between 25 and 65 MeV. At higher energies the observed flux of downward-moving electrons is consistent with being atmospheric secondaries; we give 2σ upper limits to the return albedo flux of 22, 12, and 6 electrons/m² sec ster in the energy intervals of 65 to 131, 131 to 411, and 411 to 1149 MeV, respectively. These return albedo fluxes are significantly lower than corresponding fluxes previously reported by S. D. Verma but are consistent with results of a calculation by C. J. Bland. Comparison between our observations at Fort Churchill and observations at Palestine indicates a significant contribution to the splash albedo flux from primary particles with rigidity below 4.5 GV. (auth)

44210 THE DAILY VARIATION OF TRAJECTORY-DERIVED HIGH-LATITUDE CUTOFF RIGIDITIES IN A MODEL MAGNETOSPHERE. Smart, D. F.; Shea, M. A. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res., 74: 4731-8 (Sept. 1, 1969).

Utilizing the trajectory-tracing procedure, the vertical cutoff rigidity was calculated at various latitudes along the 260°E meridian for 8 different local times using a model of the magnetosphere represented by a sixth-degree expansion of the internal field combined with external sources due to currents in the tail and the magnetopause. It was found that cutoff rigidities calculated in this magnetospheric model have a pronounced daily variation between the invariant latitudes 60° and 75°, with maximum values near noon and minimum values near midnight. At each local time, vertical cutoff rigidities calculated by means of this model are less than the values found previously by using only internal magnetic-field sources, and the lowest rigidity particles incident at any local time arrive via the magnetospheric tail. It was also found that the daily variation of the proton cutoffs is asymmetric with respect to local noon, the dawn cutoff values being higher than the cutoff values for twilight. This effect is attributed to the longitudinal asymmetry of the magnetosphere. The electron daily variation curve has the inverse asymmetry. Various proton and electron experimental results are found to be consistent with these theoretical calculations. (auth)

44211 DELAYS OF PARTICLES IN EXTENSIVE AIR SHOWERS. Bosia, G.; Navarra, G. (CNR, Turin. Univ., Turin). Nuovo Cim., 62B: 301-8(Aug. 11, 1969).

Some features of the temporal distribution of the electrons in extensive air showers by means of the diffusion equations (Landau

equations) in the A approximation are considered. The results are compared with data from experiments and Monte Carlo calculations. (auth)

44212 HIGH-ENERGY ALBEDO AND SOLAR NEUTRONS NEAR THE TOP OF THE ATMOSPHERE. Zych, Allen Dale. Cleveland, Case Western Reserve Univ., 1968. 154p.

Thesis.

Measurements of high-energy neutrons from 12 to 100 MeV near the top of the Earth's atmosphere are reported here for two balloon flights from Palestine, Texas. A polyethylene radiator in the form of plates in a spark chamber is used to detect protons produced by the incident neutron flux. For the first flight on 22 July 1967 at 9 g/cm^2, the energy and zenith angle dependence of the proton emission spectrum per unit volume of radiator due to albedo neutrons was determined. An $E^{-2.38\pm1.13}$ energy dependence for E > 20 MeV and a $[\cos(\theta)]^{-1.3\pm1.2}$ angular dependence for $\theta <$ 64° were found. The proton spectrum has been interpreted as due to a highly anisotropic high energy neutron flux where the dominant interaction for the neutrons is with the carbon in the polyethylene. A lower limit for the albedo neutron flux at 9 g/cm^2 above 20 MeV of 0.16 neutrons/cm^2 sec was determined. For the second balloon flight on 28 July 1967 at 7 g/cm^2, the detector was directed upward. The proton emission spectrum for the downward moving neutrons was very much the same as for the albedo neutrons. The lower limit for the downward neutron flux at 7 g/cm^2 above 20 MeV is 0.11 neutrons/cm^2 sec. Two importance 1 solar flares occurred with the detector at float altitude. No evidence of solar neutrons was observed. An upper limit of 5×10^{-3} neutrons/cm^2 sec for solar emission of neutrons above 12 MeV was set for these flares. The efficiency of the detector at 50 MeV was used to determine this sensitivity. (Diss. Abstr.)

44213 THE EFFECT OF SOLAR CORPUSCULAR RADIATION OF THE 1963 FINAL SPRING WARMING IN THE ANTARCTIC. Manson, Alan H. (Univ. of Saskatchewan, Saskatoon, Can.). J. Atmos. Sci., 26: 587-93(May 1969).

The possibility was examined that solar corpuscular penetration of the higher atmosphere, rather than an advective–dynamic process, may be responsible for the seasonal changes of temperature and ozone in the Arctic and Antarctic stratosphere. The 1963 final Spring warming in the Antarctic stratosphere is discussed with reference to the energy flux of electrons precipitated during the event. Temperature changes occurring throughout the atmosphere at this time are estimated. The change in thermospheric temperature (~110 km) due to particle influx is shown to be ~15°K, when allowance is made for losses due to molecular conductivity, eddy transport, and radiation. It is shown that this heating could lead to a greater deposition of gravity wave energy near 110 km in the auroral zone, and a further increase in local temperature. The resulting changes in the midlatitude zonal wind above 80 km would lead to a modification in the large-scale wave activity at these heights. Although these mechanisms may not constitute an initial triggering mechanism for the planetary wave associated with the stratospheric warming of 1963, they could lead to a correlation between the particle influx, and the midlatitude stratospheric and thermospheric parameters. Consideration of the photochemistry of ozone suggests that the auroral emissions were too weak to introduce a mesospheric–stratospheric temperature perturbation capable of destabilizing the dynamic structure of that region. There is insufficient atmospheric data to confirm the hypothesis that auroras or particle influx events are responsible for the onset of stratospheric warmings. (BBB)

44214 INVESTIGATION OF THE ISOTROPY IN DIRECTION OF MODERATE-ENERGY MUONS PRODUCED BY COSMIC-RAY NEUTRALS. Hesse, Philip Wolfe. Washington, D. C., Catholic Univ. of America, 1968. 53p.

Thesis.

Muon tracks, observed within a cubic-meter spark chamber, were projected on the celestrial sphere and resulted in concentrations, particularly at 11 hours right ascension, 20° declination and 8.5 hours right ascension, 25° declination, indicating possible sources of cosmic-ray neutrals. The concentrations follow a nonrandom distribution on the celestial sphere, while parameterization data for fictitious coordinates resulted in a random distribution. (Disser. Abstr.)

Direct Energy Conversion

Refer also to abstracts 43456 and 44229.

44215 (AD-686000) MAGNETOHYDRODYNAMIC GENERATORS. VOLUME I. Report Bibliography, 1953-December 1968. (Defense Documentation Center, Arlington, Va.). Mar. 1969. 259p. (DDC-TAS-69-5). CFSTI.

This Volume of a two-volume set was prepared from the DDC collection and covers a period from 1953 to December 1968. It contains 211 unclassified and unlimited references and computer-generated indexes of Corporate Author Monitoring Agency, Personal Author, and Contract number. (auth) (USGRDR)

44216 (AECL-Pak-Lib-28) THERMOELECTRICITY (A BIBLIOGRAPHY). Rafique, M. M.; Saleem, M. (Atomic Energy Centre, Lahore (Pakistan). Library Div.). Mar. 1969. 64p. Dep. CFSTI (U. S. Sales Only).

A list of 615 references to unclassified and published literature covering the period from 1957 to 1968 is presented. (W.H.K.)

44217 JAERI RARE-GAS MHD POWER GENERATION EXPERIMENTAL DEVICE. Yano, Shukuro (Japan Atomic Energy Research Inst., Tokai). Nippon Kikai Gakkaishi, 72: 429-32 (Mar. 1969). (In Japanese).

The experimental rare-gas MHD power generation device in JAERI, is described together with some experiments with the device. The device consists of a plasma jet as the heat source, a potassium seed device, electromagnets, measuring devices, an evaluation device, a means for mixing argon and seed, and testing channels. The functions of this device have been expanded from year to year. These functions include: from 1962 to 1965, high-temperature experiments employing a plasma generator; from 1964 to 1966, installation of electromagnets and the study of the potassium seeding; from 1967 and thereafter, studies on nonuniformity in the plasma path, and effect of the application of an electric field. Experiments have been performed with the device since 1965 on the power-generating characteristics. The range of the experiment is as follows, flow cross section, 4 to 15 cm^2; electrode dividing ratio, 0.05 to 1.2; temperature range of 1600 to 3000°K; seeding ratio, 10^{-4} to 2×10^{-2}; magnetic field intensity, 0 to 2 Wb/m^2; Hall coefficient <60. (TSS) (NSA of Japan)

44218 METHOD FOR THE PRODUCTION OF THERMOELECTRIC GENERATORS. Gillot, Roland (to EURATOM). British Patent 1,162,106. Aug. 20, 1969. Priority date Dec. 20, 1965, Germany.

A method is described for the production of a mechanical connection between a metal electrode and a surface of a germanium telluride semiconductor body of a thermoelectric generator. The electrical contact resistance is less than 100 micro-ohms/cm^2. (M.O.W.)

44219 MHD GENERATOR CYCLE WITH LIQUID METAL. Bayer, Zdenek (Inst. for Thermomechanics, Prague). Strojnicky Cas., No. 2-3, 369-80(1968). (In Czech.).

An analysis is made of the MHD generator thermal cycle using liquid metal and a condensing nozzle. The influence of the basic thermodynamic cycle parameters furthers the influence of irreversibilities in the cycle, and the influence of characteristic parameters of the working fluid on the thermal efficiency is determined. The importance of the critical temperature is indicated. By multi-stage arrangement of the condensing nozzle, the influence of the stage number on nozzle efficiency is estimated, and an approximate expression for the optimum energy distribution to the individual stages is derived. (ATD)

44220 PERFORMANCE CHARACTERISTICS OF AN MHD POWER GENERATOR WITH SEEDING PLANE AND STAGGERED ELECTRODES. Michiyoshi, Itaru; Numano, Masahiro (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 443-51(Aug. 1969).

The influences of the seeding position and the electrode staggering on the electrical performance characteristics of a Faraday-type MHD power generator are investigated theoretically. The analysis was made by means of conformal mapping techniques. The results revealed the following: influences in question can be expressed by a parameter determined uniquely by the generator geometry; internal resistance of the generator is independent of the direction of the electrode staggering; there exists a value of stagger at which the internal resistance is minimized for a finite seeding aspect ratio; the electric current concentration on the electrode edge can be attenuated by suitably staggering the electrode; and generators with a single electrode pair and those with segmented electrodes have quite similar current density profiles on the electrode surfaces, but rather different distributions on the generator center line. (auth)

44221 INSTABILITY OF OPERATION IN A HALL GENERATOR WITH NONEQUILIBRIUM IONIZATION. Petit, Jean-Pierre (Univ., Aix-Marseille, France). Compt. Rend., Ser. A, 268: 906-9(Apr. 21, 1969). (In French).

A first calculation is made of the electrical characteristics of a Hall generator with nonequilibrium ionization. Plasma homogeneity is hypothesized. The calculation was made on a binary gas mixture composed of 30% Ar and 70% He. The T_e =

$f(R_e)$ curves were calculated for temperatures from 3000 to 12,000°K for a constant field of 2 Ts. The results show that for a given value of R_e there are three corresponding values of T_e or three possible regimes of operation. One of these regimes corresponds to an unstable operation. The $P_e = f(\eta)$ curves were calculated for different values of T_g. The conditions for ignition in a linear pipe and a disc pipe were given. (J.S.R.)

Fluid Physics

44222 (AD-685173) BAROCLINIC, ALFVEN, AND ROSSBY WAVES IN GEOSTROPIC FLOW. Report No. Scientific-4. Gilman, Peter A. (Colorado Univ., Boulder). Mar. 1969. Contract F19628-67-C-0304. 28p. (AFCRL-69-91). CFSTI.

Further results are given concerning geostrophic baroclinic flow in a zonal magnetic field. In particular, the following are given: (1) a necessary condition for instability that is analogous to one for stratified shear flow found by Howard and Miles; (2) bounds on the phase velocities of all neutral oscillations; (3) explicit solutions for these neutral modes in certain cases; and (4) solution to the Eady problem (baroclinic flow with constant shear) in a zonal magnetic field without and with the beta effect. (auth) (USGRDR)

44223 (N-69-24920) A NEW MOMENTUM INTEGRAL METHOD FOR TREATING MAGNETOHYDRODYNAMIC AND SIMPLE HYDRODYNAMIC ENTRANCE FLOWS. Schwirian, Richard E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 30p. (NASA-TN-D-5215). CFSTI.

A new momentum integral method was devised for describing the incompressible flow of a conducting fluid in the entrance of a magnetohydrodynamic channel. The method is distinctive in that an edge stress is permitted to exist at the point of intersection of the boundary layer and the free stream. A prudent choice of the edge stress variation forces the governing differential equation to yield an asymptotic solution with the correct wall stress. Accurate analytical solutions are obtained for laminar flow with and without a magnetic field. Nonmagnetic turbulent flow is also well described by this method. (auth) (STAR)

44224 (N-69-30083) PRECURSOR IONIZATION EFFECTS ON MAGNETOHYDRODYNAMIC SWITCH-ON SHOCK STRUCTURE. Hoffert, Martin I. (New York Univ., N. Y. School of Engineering and Science). Mar. 1969. 38p. (NASA-CR-101680; F-69-3). CFSTI.

The influence of shock-induced precursor ionization on the steady-state structure of switch-on shock waves with nonequilibrium ionization and radiation is examined theoretically. A single-temperature monatomic gas is assumed, together with a Clarke–Ferrari model for photoionization of the upstream gas. It is found that the effect of the precursor depends in general on the ratio of a characteristic precursor length to a characteristic magnetic interaction length. For the slightly ionized case treated in some detail, this ratio is much greater than unity, indicating a precursor independence for the magnetohydrodynamic shock structure. (auth) (STAR)

44225 HYDROMAGNETIC STABILITY OF FREE FLOWS AT LARGE REYNOLDS NUMBERS. II. TWO-DIMENSIONAL JET. Gotoh, Kanefusa; Nakata, Isamu (Kyoto Univ.). J. Phys. Soc. Jap., 27: 490-7(Aug. 1969).

The effect of an aligned uniform magnetic field upon the stability of a two-dimensional jet is investigated for large values of the Reynolds number R. The wave-number α and the phase velocity c_r of the neutral disturbance are obtained as functions of the Alfvén number A, the magnetic Prandtl number γ and R. The critical Alfvén number A_c is found to be 0.34 for infinite value of αR and it does not exceed this value even for finite values of αR. (auth)

44226 ELECTROHYDRODYNAMIC RAYLEIGH- AND OSCILLATING PLATE-PROBLEMS. Kuwabara, Sinzi (Tokyo Univ.). J. Phys. Soc. Jap., 27: 484-9(Aug. 1969).

Dynamics of a viscous, electrically charged, simple gas is studied. The Navier–Stokes equations for the charged gas are the basis of the analysis. The assumption that the gas is "incompressible" and isothermal simplifies the fundamental equations. As typical examples, the Rayleigh- and oscillating plate-problems are examined. The velocity distributions and the shear stresses on the plate for these flows are calculated. (auth)

44227 HYDROMAGNETIC STABILITY OF FREE FLOWS AT LARGE REYNOLDS NUMBERS. III. FREE BOUNDARY LAYER WITH SMALL MAGNETIC PRANDTL NUMBER. Gotoh, Kanefusa (Kyoto Univ.); Numata, Takao. J. Phys. Soc. Jap., 27: 764-71(Sept. 1969).

The effects of a uniform parallel magnetic field upon the stability of a free boundary layer of an incompressible, electrically conducting fluid with small magnetic Prandtl number γ are investigated for flows of large Reynolds number R. The condition for stabilizing the disturbance with the wave number α is obtained as a relationship between $N(=\gamma RA^2$, A: the Alfvén number), αR and γ. (auth)

44228 SOLUTIONS OF THE LINEARIZED EQUATIONS OF MAGNETOHYDRODYNAMICS IN NONHOMOGENEOUS MAGNETIC FIELDS. Infeld, Eryk (Inst. of Nuclear Research, Warsaw). Phys. Fluids, 12: 1845-8(Sept. 1969).

Earlier results, concerning the conditions when the solutions of the linearized equations of magnetohydrodynamics are exact, are extended. Only a partial answer to the question is still possible for varying initial fields. An exact solution is given as an illustration. This solution might be useful as a model for investigating the effect of currents on Alfvén waves in the radiation belts. (auth)

44229 RELAXATION PROCESSES IN NONEQUILIBRIUM MAGNETOHYDRODYNAMIC PLASMAS. Takeshita, Toshihide. Berkeley, Calif., Univ. of California, 1968. 175p. Thesis.

In a fluid flow of an electrically conductive medium, there exists a strong interaction between the fluid and electromagnetic forces. For alkali-seeded rare gases, Joule heating enhances the electron temperature, and induces nonequilibrium ionization in the plasma. The details of this process are investigated in this thesis in the context of magnetohydrodynamic energy conversion systems. The excitation and ionization relaxation of cesium seeded argon gas is calculated numerically for a stepwise increase of electron temperature. The rate equations are given by the balance of inelastic excitations, superelastic de-excitations and radiative transitions between the levels. Excitation and ionization cross sections are calculated according to Gryzinski's equations. The energy levels near the continuum are assumed to be in equilibrium with the electron density and the change in populations of the lowest eight levels of cesium is considered. The electron density is obtained from the conservation of total number of cesium atoms and ions. In order to investigate the effect of radiative transitions on the ionizational relaxation process, the radiative energy loss from the cesium seeded argon gas in local thermodynamic equilibrium is calculated, taking account of Van der Waal's broadening, resonance broadening and Stark broadening. The radiative energy losses from the transient nonequilibrium plasma are obtained by multiplying the LTE result by a correction factor based on the instantaneous populations of each level. It is found that the effect of radiations on the relaxation process is not significant over 2000°K. The net radiative transitions lower the populations of the excited state, and this deviation from LTE is calculated from rate equations. For a 10-cm-thick plasma slab the calculations show that populations of the excited states drop off very sharply from equilibrium values at temperatures around 1800°K, while the electron density becomes as low as 3×10^{-4} of the equilibrium density at a temperature of 1760°K in the case when the wall is cool. These results are applied to the relaxation process in an applied electric field and in nonequilibrium MHD flow, and the relaxation time is obtained as a function of a characteristic time based on initial Joule heating rate. It is found that most of the Joule heating goes into excitation and ionization energy losses giving a linear dependence of the relaxation time on the characteristic time. Further analysis is performed for the experimental results of full scale MHD power generation. (Diss. Abstr.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 44090, 44091, 44101, and 44222.

44230 (AD-679719) RADON CONCENTRATION AND VERTICAL TURBULENT MIXING IN THE LOWEST ATMOSPHERIC LAYER. Milin, V. B.; Malakhov, S. G.; Zorina, K. I.; Sisigina, T. I. Translation of a Monograph. 13p. (FTD-HT-23-1168-67). CFSTI.

The results are described of an analysis of simultaneous measurements of radon concentration in the surface boundary layer of the atmosphere (low-temperature radon-concentration determination using liquid nitrogen and the activated carbon-absorption method) and in the soil, the amount of radon exhaled from the surface, and the coefficient of vertical turbulent mixing. Two series of measurements were made—one 7 km south of Kirov in the summer of 1950 mainly under convective conditions, and the second in the Moscow region in the summer of 1962 with a surface boundary layer inversion. The effect of vertical turbulent mixing on the con-

centration of radon in the surface boundary layer was determined to be of major significance. (auth) (USGRDR)

44231 (AD-679795) BEHAVIOR PATTERNS IN THE E_s LAYER IN THE AURORAL AND CIRCUMPOLAR REGIONS. Gorbushina, G. N. Translated from Tr. Arkt. Antarki. Nauch.-Issled., 280: 91-9(1966). 20p. (FTD-MT-24-117-68). CFSTI.

The sporadic E layer is observed over all regions of the Earth, but its form differs from place to place, and a classification of the E_s layer, based on differences in the external appearance of recordings of reflections on ionograms, was developed. Three primary classes of sporadic layers are differentiated: the flat E_s layers (types l, c, h, and f), which are usually semitransparent, resulting in partial reflection of radio waves; E_s layers with group delay and magnetoionic splitting (E nocturnal and E_s type r); and diffuse E_s layers (types a, q, and s). These primary types of E_s layers are described, and the distribution by latitudes, as observed at various times of day, are presented graphically. Data are presented for latitudes of 60° and higher. (USGRDR)

44232 (AD-681464) ROCKET INSTRUMENTATION FOR AURORAL MEASUREMENTS: AEROBEE 3.615. Report No. Scientific-10. Baker, Kay D.; Burt, David A.; Haycock, Ralph H.; Seljaas, Karl G.; Howlett, L. Carl (Utah Univ., Salt Lake City. Upper Air Research Lab.). Sept. 1968. Contract AF19(628)-4995. 125p. (UU-68-10; AFCRL-68-538). CFSTI.

An Aerobee rocket (3.615) was instrumented with a sophisticated array of devices for simultaneous, direct measurement of many parameters associated with the polar ionosphere during a visible auroral event. The instruments included electron and proton counters and scintillators, electron and ion density and temperature probes, x-ray counters, and auroral light photometers. Details of the rocket payload and the 24 different sensors are presented. (auth) (USGRDR)

44233 (AD-681724) LOW-FREQUENCY INTERCHANGE INSTABILITIES OF THE RING CURRENT BELT. Liu, C. S. (California Univ., Los Angeles. Plasma Physics Group). Jan. 1969. Contract Nonr-4756(01). 60p. (R-38). CFSTI.

The stability of the ring current belt against low-frequency, electrostatic perturbations is analyzed, with the effect of a finite electric field along the magnetic line of force included. Four possible instabilities are found: the hydromagnetic interchange, the trapping instability, the low-frequency flute mode, and the resonant interchange; the conditions for their occurrence in the ring current belt are derived. Due to the parallel electric field associated with the instabilities, their main consequence is to precipitate charged particles into the ionosphere, leading to ring current pressure relaxation. Their possible relevance to observations is discussed. (auth) (USGRDR)

44234 (AD-681774) AN ANALOG COMPUTER SOLUTION OF THE WAVE INTERACTION EQUATION. Report No. Scientific-332. Horwitz, M. J. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Jan. 10, 1969. Contract Nonr-656(35). 66p. CFSTI.

An analog computer program is presented to solve the radio-wave interaction equation for the case of finite wanted and disturbing pulses with the disturbing pulse power having a time dependency of $\sin(\pi t/\tau_D)^4$. The program is capable of varying some of the important variables involved in the equation such as electron density, collision frequency, and electron temperature. Some typical curves are shown to demonstrate the accuracy and applicability of the program. Finally, a critical analysis is presented that shows the advantages and disadvantages of the analog computer program. (auth) (USGRDR)

44235 (AD-681885) D-REGION PARAMETERS FROM CONTINUOUS WAVES, LOW FREQUENCY, ROCKET PROPAGATION EXPERIMENTS DURING THE SOLAR ECLIPSE OF NOVEMBER 12, 1966. Final Report (Part A). Report No. Scientific-323. Mavretic, Anton (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Sept. 1, 1968. Contract DAAD05-67-C-0005. 147p. CFSTI.

During the course of the total solar eclipse of November 12, 1966 in Cassino, Brazil a series of four rockets were fired carrying a continuous-wave, low-frequency propagation experiment to measure the rate of change of magnetic field strength with altitude. From this rate, electron density profiles were deduced with the aid of a computerized full-wave solution technique. From the variation of electron density with time and a continuity equation for electrons, the effective recombination coefficient was obtained in the altitude range from 64 to 73 km. From the known positive ion profiles during the same eclipse the negative ion-to-electron density ratio was deduced and used to obtain the effective ion-ion recombination coefficient versus altitude. (auth) (USGRDR)

44236 (AD-682489) ANALOG SOLUTIONS OF FULL WAVE DIFFERENTIAL EQUATIONS. Report No. Scientific-333. Cohen, D. J. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Jan. 20, 1969. Contract Nonr-656(35). 89p. CFSTI.

Four full-wave differential equations are solved by use of an analog computer to obtain reflection coefficients and equivalent heights for parabolic layers. The analog computer easily and inexpensively plotted solution curves to the full-wave differential equations. Numerous sets of these solution curves are presented to show the effects of parameter changes on the solutions of the differential equations. (auth) (USGRDR)

44237 (AD-682507) MANUAL ON SHORT-TERM PREDICTION OF IONOSPHERIC GEOMAGNETIC STORMS AND RADIO-PROPAGATION FORECASTING SERVICE. Zevakina, R. A.; Lavrova, E. V.; Lyakhova, L. N. Translation of a Monograph. 95p. (AFCRL-68-323; AFCRL-Trans-9). CFSTI.

The main features of ionospheric-geomagnetic storms and their probable causes are reviewed. Disturbances in short-wave radio propagation during such storms are discussed. The principles of short-term prediction of ionospheric-geomagnetic storms are summarized and all kinds of Izmiran's forecasts are described. The application of these forecasts and current ionospheric data to calculation of usable radio propagation frequencies is explained. (auth) (USGRDR)

44238 (AD-682943) PENETRATION OF SOLAR PROTONS TO SYNCHRONOUS ALTITUDE. Technical Report, January-October 1968. Paulikas, George A.; Blake, J. Bernard (Aerospace Corp., El Segundo, Calif.). Dec. 1968. Contract F04701-68-C-0200. 29p. (TR-200(4260-20)-4; SAMSO-TR-69-22). CFSTI.

Solar proton fluxes in two energy intervals (5 to 21 MeV and 21 to 70 MeV) were measured with detectors aboard the geostationary ATS-I satellite during the solar proton event which began on January 28, 1967. Comparison with data obtained by satellites outside the magnetosphere shows that: (a) protons with energies greater than 21 MeV have essentially free access to synchronous altitude; (b) protons in the 5- to 21-Mev energy interval show a diurnal variation with the flux approaching the interplanetary flux level near local midnight. The transmission efficiency of the magnetosphere is not well organized by either the local (synchronous) magnetic field or the K_p index. (auth) (USGRDR)

44239 (AD-683336) IONOSPHERIC RESEARCH. Final Report, September 1, 1963-November 30, 1968. Waynick, Arthur H. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Nov. 30, 1968. Contract AF19(628)-4014. 60p. (AFCRL-68-658). CFSTI.

The report contains theoretical and experimental investigations on the physics, dynamics, and aeronomic properties of the Earth's and other planetary atmospheres. Also involved were theoretical and experimental studies of various relevant atomic and molecular rate coefficients. (auth) (USGRDR)

44240 (AD-683341) EFFECTS OF STARFISH ON GEOMAGNETICALLY TRAPPED PROTONS. Final Report, June 1, 1967-February 28, 1968. Cladis, John B.; Davidson, Gerald T.; Francis, William E.; Jaggi, Rahde K.; Nakano, George H. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Feb. 1969. Contract F19628-67-C-0310. 58p. (LMSC-682602; AFCRL-69-32). CFSTI.

Measurements of geomagnetically trapped, 55-MeV protons made before and after the detonation of the Starfish nuclear device revealed that at low altitudes the flux increased considerably after the Starfish burst. Theoretical analyses presented here indicate that the flux change resulted from a redistribution of the existing trapped protons in the inner zone. Two processes were found to alter the proton distribution appropriately: (1) interaction of the protons with hydromagnetic waves produced by the burst and, (2) multiple reflections of the protons from a magnetic field inhomogeneity which propagates along magnetic field lines with local hydromagnetic velocity. If the hydromagnetic velocity is determined from approximately ambient plasma densities, the latter mechanism (the Fermi process) gives the same altitude dependence of the increased flux as that obtained from the measurements. However, much higher plasma densities, or repeated traversals of the field line by the magnetic front, is required to explain the magnitude of the observed flux change. (auth) (USGRDR)

44241 (AD-684439) VLF ELECTRIC AND MAGNETIC FIELDS OBSERVED IN THE AURORAL ZONE WITH THE JAVELIN 8.46 SOUNDING ROCKET. Progress Report. Gurnett, Donald A.; Mosier, Stephen R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan. 1969. Contract Nonr-1509(06). 45p. CFSTI.

Results of the Javelin 8.46 vlf electric magnetic fields experiment flown from Ft. Churchill, Canada, on May 25, 1968, are discussed. This experiment carried three orthogonal magnetic loop

antennas, three orthogonal long (3.16 meters) electric dipoles, two short (42 cm) electric dipoles, and six wideband (30 Hz to 10 kHz) receivers for amplifying signals from the various vlf antennas. Intense noise bursts with frequencies less than about 1.5 kHz were observed on all the electric antennas below 500-km altitude, but not on the loop antennas. The precession and spin modulation of these noise bursts suggest that the noise is generated by an interaction between the payload and the surrounding plasma. High-frequency electrostatic noise bursts, from 5 to 30 kHz, were observed throughout the flight. These noise bursts, similar in some respects to lower-hybrid-resonance noise commonly observed with satellite vlf electric field experiments, also appear to involve an interaction between the payload and the surrounding plasma. Attenuation bands at harmonics of the proton gyrofrequency were also found in the frequency spectra of electric field noise observed during a portion of the flight. (auth) (USGRDR)

44242 (AD-684914) REMARKS ON THE MATCHING OF TOPSIDE AND BOTTOMSIDE ELECTRON DENSITY PROFILES OF THE IONOSPHERE. Arendt, P. R. (Army Electronics Command, Fort Monmouth, N. J.). Feb. 1969. 17p. (ECOM-3077). CFSTI.

Limits for deviation from matching are assumed to be less critical when ionospheric stratification applies. However, a case of good matching was observed during a magnetic storm. The reported observations are not conclusive: good matching occurred with poor time coincidence; however, relatively poor matching occurred with good position and time coincidence. Layer tilting and horizontal fine structure have to be studied in more detail. (auth) (USGRDR)

44243 (AD-685602) NEUTRAL D-REGION CHEMISTRY FOLLOWING HIGH-LEVEL IONIZATION IMPULSES. Scheibe, Murray (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). July 1968. Contract N00014-67-C-0141. 42p. (LMSC-N-68-1). CFSTI.

The changes in the neutral constituents in the D region following high-level ionization pulses, such as those caused by nuclear detonations, is reexamined with regard to the effects of undated rate constants, charged-particle reactions, and ambient neutral constituents. The major differences from the results of Branscomb and LeLevier are: longer persistence of the nitrogen atom concentrations; early formation by charged-particle reactions of high levels of nitric oxide, and to a lesser extent, of nitrogen dioxide during the day; and the formation of N_2O, which has a decay time measured in months. (auth) (USGRDR)

44244 (AD-686114) SATELLITE PLASMA FREQUENCY PROBE FOR HIGH SPATIAL RESOLUTION ELECTRON DENSITY MEASUREMENTS. Report No. Scientific-11. Pound, Earl F.; Burt, David A. (Utah Univ., Salt Lake City. Upper Air Research Lab.). Dec. 1968. Contract AF19(628)-4995. 68p. (UU-68-11; AFCRL-68-672). CFSTI.

Instrumentation for a satellite experiment called a plasma frequency probe designed to provide high-resolution measurements of electron density for investigation of F-region irregularities is described. The plasma frequency probe technique involved determination of electron density and electron temperature by measuring the resonance frequencies of an antenna immersed in the plasma. A low-level rf voltage, swept from 19 to 0.1 MHz, is applied to a short-whip antenna, and the resonances are determined by the use of a broadband phase detector. The resonance frequencies are measured eight times per second (approximately every kilometer), coded for PCM telemetry, and recorded on a 10-hour storage capacity tape recorder. With a playback-to-record speed ratio of 80 to 1, ten hours of recorded data can be replayed on a single satellite pass. The units described were flown on polar-orbiting satellites OV3-5 and OV3-6. (auth) (USGRDR)

44245 (AD-687395) ELECTRON-CONTENT VARIATIONS AND CHANGE RATES OBTAINED DURING THE SPRING AND SUMMER OF 1967 BY THE MEASUREMENT OF FARADAY ROTATION OF 137 MHz RADIO WAVES TRANSMITTED FROM ATS-1. Goodman, John M.; Lehman, Melvin W.; Piernik, Edward (Naval Research Lab., Washington, D. C.). Mar. 17, 1969. 27p. (NRL-6830). CFSTI.

Vhf radiowave transmissions (137-350 MHz) from the geostationary satellite ATS-1 (1966-110A) were analyzed to determine the electron-content variations during the Spring and Summer of 1967. The regularities of the ionosphere during the observation period were found to be roughly the same as those which were observed during the Early Bird observation period of 1965. In particular, it was found that there exist two extremal regions of the content-change rate function—one associated with sunrise and one associated with sunset. Irregularities in the electron content were observed to occur during both magnetically quiet and disturbed days, although extremely dramatic enhancements were recorded following two magnetic storms. Although a Chapman distribution is barely justifiable theoretically, it was found that the diurnal excursion is roughly proportional to the diurnal excursion in the square of f_0F2 as predicted by simple Chapman theory. (auth) (USGRDR)

44246 (AD-688221) THE ELECTRON CONTENT IN THE POLAR F-REGION. Progress Report No. 8, November 1, 1967–October 31, 1968. Report No. Scientific-2. Bratteng, Ove M.; Frihagen, Jon (Auroral Observatory, Tromso (Norway)). Feb. 20, 1969. Contract F61052-67-C-0020. 43p. (AFCRL-69-179). CFSTI.

Some results of electron content measurements in the polar F region are presented. There is an enhancement of electron content close to local geomagnetic noon in the latitude interval 76 to 80N. There are indications of a maximum in electron content close to 2000 UT at 78N in winter. Total electron content variations with geomagnetic activity is unclear. It seems that there is almost always a rapid and large increase in electron content related to micropulsation events. (auth) (USGRDR)

44247 (AD-688440) INITIAL OBSERVATIONS OF VLF ELECTRIC AND MAGNETIC FIELDS WITH THE INJUN 5 SATELLITE. Progress Report. Gurnett, Donald A.; Pfeiffer, G. William; Anderson, Roger R.; Mosier, Stephen R.; Cauffman, David P. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Apr. 1969. Contracts Nonr-1509(06); NAS5-10625. 63p. CFSTI.

The Injun 5 satellite, launched into a low-altitude (677 to 2528 km) polar orbit on August 8, 1968, carried a very-low-frequency (vlf) electric and a magnetic field experiment, covering the frequency range from dc to 105 kHz for electric fields and 30 Hz to 10 kHz for magnetic fields. This paper describes the vlf experiment and presents initial results of immediate interest. Broad band (30 Hz to 10kHz) electric field intensities are found to be remarkably small, typically less than 100 μV/m and seldom greater than 1 mV/m. Most of the common types of vlf electromagnetic noise, electron and proton whistlers, chorus, elf hiss, vlf hiss, and periodic emissions were observed simultaneously with both the electric and magnetic antennas, thus providing an excellent check on the operation of the electric antenna. Phase measurements between the electric and magnetic fields were used to determine the direction of propagation, up or down the geomagnetic field. New phenomena observed include: (1) spin modulation of lower hybrid resonance noise, (2) multiple frequency noise bands possibly related to lower hybrid resonance noise, (3) a narrow bandwidth electric field enhancement near the two-ion cutoff frequency, and (4) noise bands associated with harmonics of the proton gyrofrequency. (auth) (USGRDR)

44248 (AD-688441) LARGE TEMPORAL VARIATIONS OF ENERGETIC ELECTRON INTENSITIES AT MID-LATITUDES IN THE OUTER RADIATION ZONE. Progress Report. Yeager, D. M.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb. 1969. Contract Nonr-1509(06). 42p. CFSTI.

A thorough search of Explorers 12 and 14 observations of electron (40 keV < E < 2 MeV) intensities within the outer radiation zone during the period 1961 to 1963 has provided evidences of several catastrophic rapid decreases and recoveries of these electron intensities within periods of approximately several minutes at L values of approximately 5 to 6. Typical values for these intensity fluctuations are by factors >500, >100 and >1000 for electrons E > 40 keV, 230 keV, and 1.6 MeV, respectively. A comparison of the temporal variations of integral energy spectrums of electron intensities, latitudes of the observed events, ground-based observations of auroral magnetic activity, and low-altitude measurements of electron intensities within the above energy range allow this striking phenomenon to be interpreted in terms of redistribution of these outer zone electrons during the distortion of the geomagnetic field by the low-energy plasma producing the associated magnetic disturbance and of conservation of the first two adiabatic invariants Mu and I. The principal features of these events are adequately accounted for with the above interpretation, as the signature of the motion of the "trapping boundary" for energetic electrons at midlatitudes in the dark hemisphere of the magnetosphere, which eliminates the alternative assumption of an almost unreasonably strong acceleration mechanism for outer-zone energetic electrons. (auth) (USGRDR)

44249 (CONF-680661-(Absts.)) SYMPOSIUM ON PHYSICS AND CHEMISTRY OF THE UPPER ATMOSPHERE, 12–13 JUNE 1968, WALTHAM, MASSACHUSETTS. Program and Abstracts. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 78p.

Abstracts are given of papers presented at the three sessions: (1) Negative Ion and Neutral Reaction Studies, (2) Atmospheric Properties, and (3) Positive Ion Reactions. (M.O.W.)

44250 (JPRS-48528) UPPER ATMOSPHERE AND SPACE RESEARCH IN THE USSR IN 1968. Efremov, Yu. I. (ed.). Translated from Issledovaniya Verkhney Atmosfery i Kosmicheskogo Prostranstva Vypolnennyye v 1968 Godu; Russian, Nauka Publishing House, 1969. 111p. CFSTI.

This report briefly describes the basic results of space studies whose results were fully or partially analyzed during 1968. Topics covered include the Moon and planets, investigation of physical processes and phenomena transpiring in space, short-wave electromagnetic radiation of the Sun and stars, meteorological research, biomedical research, further development of technical means for the conquest of space, communication systems, and use of satellites for communication and weather. (W.D.M.)

44251 (N-69-20849) LOCAL TIME ASYMMETRIES IN THE INCREASE OF ELECTRON FLUXES IN THE OUTER VAN ALLEN ZONE DURING SUBSTORMS. Rao, C. S. R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Feb. 1969. Contract NAS5-3097. 35p. (NASA-CR-100419). CFSTI.

The increase was studied in the fluxes of electrons $E_e \gtrsim 40$ keV and $E_e \gtrsim 120$ keV in the outer Van Allen zone at different local times during nighttime magnetic bay activity. Electrons $E_e \gtrsim 40$ keV show increases in the midnight to afternoon sectors but not in the evening sector during bay activity. Electrons $E_e \gtrsim 120$ keV do not, however, show significant increases at these times. Also, whereas the increase in the midnight sector occurs immediately after the onset of a bay, a significant increase in the morning sector occurs only later, i.e., during peak or recovery phase of the bay. This time delay is attributed to the time taken by the electrons that are freshly energized in the midnight sector to drift in longitude so as to appear in the morning sector. The absence of increase in the evening sector is believed due to the fact that the freshly energized electrons disappear by the time they drift to that sector. (auth) (STAR)

44252 (N-69-21023) IONOSPHERIC AND MAGNETIC OBSERVATIONS AT 1000 KILOMETERS DURING THE GEOMAGNETIC STORM AND AURORA OF MAY 25-26, 1967. Findlay, J. A.; Dyson, P. L.; Brace, L. H.; Zmuda, A. L.; Radford, W. E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1969. 25p. (NASA-TM-X-63491; X-621-69-64). CFSTI.

Measurements of electron temperature and density and of transverse magnetic disturbances obtained at 1000 km before, during, and after the magnetic storm and aurora of May 25-26, 1967 are compared with visual observations of the aurora and a degree of correlation is apparent. Throughout the latitudinal region of visual aurora the electron temperature and its latitudinal variations were much greater than are observed under quiet conditions. Temperatures in excess of 6500°K and temperature variations of greater than 500°K within <4 km along the satellite path were measured. Temperatures this high suggest a heat source other than auroral electron bombardment. The electron density was also extremely structured through the region of visual aurora. Horizontal gradients were observed in which the density changed by greater than 50% in less than 100 m along the satellite path. The greatest density measured was $\approx 6.5 \times 10^4/cm^3$ (at A = 53°). The magnetometer recorded a number of disturbances (as large as 306 γ) in the region of unusual density and temperature behavior. (auth) (STAR)

44253 (N-69-22774) PARTICLE MOTIONS IN A MAGNETIC FIELD. Braun, Martin (Brown Univ., Providence, R. I. Center for Dynamical Systems). Mar. 1969. 87p. (NASA-CR-100611; CDS-TR-69-1). CFSTI.

Thesis.

A theory of almost periodic motions is developed as related to the Stormer problem, a mathematical formulation of the motion of a charged particle in the geomagnetic field. By these calculations, it is possible to exhibit the trapping of charged particles as observed in the Van Allen belt. As an additional feature, it is shown that the theory can easily be generalized to any rotationally symmetric mirror field. (STAR)

44254 (N-69-23330) OGO-3 OBSERVATIONS OF ELF NOISE IN THE MAGNETOSPHERE, PART 1, SPATIAL EXTENT AND FREQUENCY OF OCCURRENCE. Russell, Christopher T.; Holzer, Robert E.; Smith, Edward J. (California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics). 1968. Contract NAS7-100. 60p. (NASA-CR-98702). CFSTI.

The magnetic noise in the magnetosphere in the frequency range from 10 to 800 was measured by the spectrum analyzers of the search coil magnetometer on OGO-3. A statistical study is presented of the spatial extent and frequency of occurrence of noise at the higher end of this passband and the frequencies at which noise above the detector thresholds is most common within the magnetosphere. The local time and magnetic latitude distribution of two classes of signals were investigated. (auth) (STAR)

44255 (N-69-24521) PROTONOSPHERIC ELECTRON CONCENTRATION PROFILES. Final Report. da Rosa, A. V.; Garriott, O. K. (Stanford Univ., Calif. Stanford Electronics Labs.). Mar. 1969. Contract NASr-136. 51p. (NASA-CR-100778; SU-SEL-68-44). CFSTI.

The local electron concentration was calculated along portions of the orbit of OGO-1, based on differential Doppler frequency and Faraday polarization rotation measurements of harmonic radio beacon transmissions. Since it is not possible to make these calculations with sufficient accuracy for most satellite orbits, an extensive error analysis is included, to establish the sources and magnitudes of the uncertainties in the computations. Values of protonospheric electron concentration were obtained between altitudes of about 6000 and 15,000 km on a number of orbits. The uncertainties in the computed values result principally from scaling errors in the Faraday polarization rotation angle and from horizontal gradients in the ionosphere; they typically total less than ±600 electrons/cm^3. A number of concentration profiles are shown and are compared with direct probe measurements, with whistler results, and with extrapolated values of electron concentration obtained from Alouette 1 near 1000 km. (auth) (STAR)

44256 (N-69-25231) DIRECT MEASUREMENTS OF ELECTRON ENERGY DISTRIBUTIONS IN DAYTIME IONOSPHERE. Huang, Philip T. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Feb. 1969. 105p. (NASA-CR-100869; TR-936). CFSTI.

Thesis.

The energy distributions of electrons in the ionospheric plasma were obtained for the energy interval of 0 to 15 eV, from the utilization of a pulse probe operated in the dc mode. The observed retarded current-voltage characteristics indicate the existence of two distinct distributions in this energy range, the thermal distribution and a secondary distribution extending to approximately 8 eV at the higher altitudes, with characteristic temperatures of 1.5 to 2.5×10^3 °K and 1 to 3×10^4 °K, respectively. Both temperatures are observed to increase with increasing altitudes in the region between 120 and 240 km. The retarded probe currents corresponding to these two distributions are exponential functions of the retarding probe potential. No valleys or humps were observed to exist in the secondary energy distribution function. The concentration of secondary electrons has the approximate values of 150 to 200 electrons/cm^3 between 150 and 240 km. (auth) (STAR)

44257 (N-69-29710) EXPERIMENTAL VERIFICATION OF DRIFT SHELL SPLITTING IN THE DISTORTED MAGNETOSPHERE. Pfitzer, K. A.; Lezniak, T. W.; Winckler, J. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Apr. 1969. 13p. (NASA-CR-101641; CR-133). CFSTI.

Electron spectrometer data from the synchronous ATS-1 and data from an electron spectrometer and ion chamber on the elliptical orbit satellite OGO-3 can be used to test drift shell splitting in the non-dipolar distorted magnetosphere. Quiet-day pitch-angle distributions obtained by ATS-1 at 6.6 R_e qualitatively confirm the shell splitting by showing that near noon the pitch-angle distribution is nearly isotropic whereas, near midnight, it is peaked toward small angles parallel to the field. Using the Mead-model magnetic field for calculating the drift shells for electrons of pitch angle $\alpha = 65°$ and $\alpha = 90°$, as well as the measured pitch-angle distribution and measured radial gradient for electrons at local noon, the pitch-angle distribution can be calculated as a function of local time for the ATS-1 orbit. Calculated and measured fluxes agree not only in predicting the proper noon to midnight asymmetry (25 to 1 for 500- to 1000-keV electrons on February 15, 1967) but also in correctly predicting the pitch-angle distribution as a function of local time (isotropic at noon but nonisotropic with a 3 to 1 ratio between $\alpha = 65°$ and $\alpha = 90°$ at midnight). However, in one case (February 15, 1967) an asymmetry is observed about local midnight with minimum count rate at 2200 LT. (auth) (STAR)

44258 (N-69-29878) INTENSITY CORRELATIONS AND SUBSTORM ELECTRON DRIFT EFFECTS IN THE OUTER RADIATION BELT MEASURED WITH THE OGO-III AND ATS-1 SATELLITES. Pfitzer, K. A.; Winckler, J. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Apr. 1969. 38p. (NASA-CR-101640; CR-136). CFSTI.

During late December 1966 and January 1967 the elliptically orbiting satellite OGO-3 entered the magnetosphere within 30° of the subsolar point and within 10° of the geomagnetic equator. This permitted the measurement of the distance to the magnetosphere boundary, which is a necessary parameter for the Mead-model magnetic field calculations. The electron fluxes measured by an electron spectrometer and an ion chamber on

OGO-3 are correlated with electron fluxes on the geostationary satellite ATS-1 at the exact time when both satellites are on the same drift shells as calculated from the Mead-model magnetic field with separations on local time up to 180°. During quiet times an absolute comparison of the fluxes from 50 to 1000 keV gives a linear relationship, indicating agreement of the measurements over a three order-of-magnitude range of intensities. During substorm increases the ATS-1 measurements have similar profiles but are delayed in time with respect to each other. The observed delays are smaller for higher-energy electrons and larger for greater separations in local time. As an example, the measured delays for 50-, 150-, and 400-keV electrons on January 11, 1967, when the local time separation was 110°, are 26, 13 to 17, and 5 minutes, respectively. (auth) (STAR)

44259 (N-69-29881) ARTIFICIAL AURORA EXPERIMENT: POSITION MEASUREMENTS OF AURORAL RAYS AND COMPARISON WITH PREDICTIONS. Mead, Gilbert D.; Mead, Jaylee M.; Davis, T. Neil (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1969. 23p. (NASA-TM-X-63578; X-641-69-221). CFSTI.

An electron accelerator, launched aboard an Aerobee 350 rocket, produced four auroral rays which were detected with image-orthicon television systems at two ground stations. The experiment was to test the feasibility of generating artificial auroras by injecting electrons into the upper atmosphere from a rocket-borne accelerator. The optical observations, the techniques employed to determine the position of the observed rays, the method used to predict the location of the rays from knowledge of the rocket orbit and the local geomagnetic field, and a comparison of the predicted and observed positions are described. It is found that the lower ends of the observed rays were located at altitudes of approximately 104 to 106 km; the upper ends were less well defined, ranging from around 120 to 130 km. The predicted positions were separated from the observed ones by less than 0.1° of arc, or about 400 meters. (auth) (STAR)

44260 (N-69-30202) ROCKET INVESTIGATION OF THE AURORA BOREALIS: SOME OF ITS PROMINENT OPTICAL FEATURES AND ITS ION COMPOSITION. Parkinson, Truman David (Pittsburgh Univ., Pa. Space Research Coordination Center). 1969. 135p. (NASA-CR-101681; SRCC-97). CFSTI.

Thesis.

Analysis of data from a series of three sophisticated Aerobee rocket experiments flown into auroral displays yielded much information concerning the excitation mechanisms of several optical emissions. Laboratory measured cross sections for the N_2^+ (O-O) first negative band, its observed volume emission rate, and measured secondary electron spectra allow calculation of the electron fluxes responsible for the N_2 first positive bands, the O_2^+ first negative bands, and the O 1 green line at 5577 Å. The molecular emissions can be accounted for in terms of direct electron impact excitation from the appropriate neutral molecule. The classical source of the green line, direct electron impact excitation of O, is shown inadequate. Dissociative excitation of O_2 and dissociative recombination of O_2^+, each dominant in its own region, are capable of producing the green line. Further confirmation of this dual source comes from a measurement of the quenching of the $O(^1D)$ state as indicated by the O 1 red line at 6300 Å. (auth) (STAR)

44261 ELECTRON DENSITY (N(h)) PROFILES ABOVE BEKESCSABA, HUNGARY. PART 1. SUNSPOT MIMIMUM. QUIET DAYS. Bencze, P. (Hungarian Academy of Sciences, Sopron). Acta Geod., Geophys. Montanistica, 4: 13-20(May 30, 1969).

Electron-density profiles were computed from ionograms of the ionospheric station at Bekescsaba (46°40′N, 21°10′E). The profiles were determined for geomagnetically quiet and disturbed days of both the maximum and minimum of the solar cycle. Quiet-day average N(h) profiles are given for the summer, equinox, and winter months of 1964. The methods employed in collecting and handling the data are described. The principal instrument used was an IRX type automatic ionosphere recorder. The procedure limited the determination of the electron-density profiles to height intervals visible on the ionogram without any extrapolation of the profile to the F2-layer maximum, respectively below f_{min}. (JPRS)

44262 EXCITATION OF THE AURORAL GREEN LINE OF ATOMIC OXYGEN ($^1S \rightarrow {}^1D$) BY $N_2(A^3\Sigma_u^+)$. Meyer, J. A.; Setser, D. W.; Stedman, D. H. (Kansas State Univ., Manhattan). Astrophys. J., 157: 1023-5(Aug. 1969).

The reaction $N_2(A^3\Sigma_u^+) + O(^3P) \rightarrow N_2(X^1\Sigma_g^+) + O(^1S)$ was investigated in a discharge flow system. An approximate rate constant of 3.2×10^{-12} cm^3 sec^{-1} was obtained. (auth)

44263 AURORAL MORPHOLOGICAL SIMILARITIES AT TWO MAGNETICALLY CONJUGATE STATIONS: BUCKLES BAY AND KOTZEBUE. Bond, F. R. (Dept. of Supply, Melbourne). Aust. J. Phys., 22: 421-33(June 1969).

A preliminary study is presented of auroral displays photographed by all-sky cameras during November 1962 to March 1963 at the approximately magnetically conjugate stations, Buckles Bay, Macquarie Island, and Kotzebue, Alaska. Within the degree of accuracy of the plotting method used, the location and shape of clearly discernible simple auroral forms during the initial quiet phase of a display are consistent with magnetic conjugacy in colatitude θ_3 (Bond and Jacka 1962). Increases and decreases in the brightness of corresponding auroral forms occurred simultaneously at both stations, to within 1 min, and were assessed to be of the same order of magnitude. During the later stages of a display, the auroral features were slightly displaced in latitude and longitude in a manner possibly related to the angle of attack of the solar wind on the magnetosphere. This information suggests conformity with the concept that electron precipitation guided along magnetic field lines is a major factor in the morphological pattern of the aurora, and that the visible aurora may portray, in miniature, the pattern of deformation in the magnetosphere of the magnetic field lines connecting the conjugate phenomena. (auth)

44264 PHYSICS OF THE MAGNETOSPHERE. Proceedings of the Conference Held at Boston College June 19-28, 1967. Carovillano, Robert L.; McClay, John F.; Radoski, Henry R. (eds.). Astrophysics and Space Science Library. Volume 10. New York, Springer-Verlag New York Inc., 1968. 695p. $39.00. (CONF-670662).

Separate abstracts were prepared for the 24 individual papers. (M.O.W.)

For abstracts of individual papers see: 44265-44288.

44265 DYNAMICAL PROPERTIES OF THE MAGNETOSPHERE. Parker, E. N. (Univ. of Chicago). pp 3-64 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

A general review discussion of the magnetosphere is given. The topics discussed are: (1) the equations for plasmas and fields, (2) convection, (3) the geomagnetic storm, and (4) structure of the magnetopause. (M.O.W.)

44266 SOLAR WIND INTERACTIONS AND THE MAGNETOSPHERE. Dessler, A. J. (Rice Univ., Houston, Tex.). pp 65-105 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

A review discussion is given on the solar wind and its interaction with the magnetosphere. Topics discussed are: (1) the solar wind, (2) the de Laval nozzle analogy for the solar wind, and (3) minimum stable solar-wind velocity. (M.O.W.)

44267 WHISTLERS AND VLF EMISSIONS. Helliwell, R. A. (Stanford Electronics Labs., Calif.). pp 106-46 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

The following topics are discussed: (1) historical background of whistlers and related phenomena, (2) the observational facts, from both the ground and satellites, (3) the application of these measurements to electron density mapping and techniques for the detection of ions using whistlers, and (4) the nature of electromagnetic emissions from the magnetosphere and ideas relating to their origin. (M.O.W.)

44268 PARTICLE DESCRIPTION OF THE MAGNETOSPHERE. Van Allen, James A. (Univ. of Iowa, Iowa City). pp 147-217 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Topics discussed include: (1) particle motions in a magnetic field, (2) Liouville's theorem, (3) the system of coordinates, and (4) observed particle distributions. (M.O.W.)

44269 WAVES AND PARTICLES IN THE MAGNETOSPHERE. Dungey, James W. (Imperial Coll. of Science and Tech., London). pp 218-59 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

The propagation of hydromagnetic waves in the magnetosphere and a mechanism for generating them at the magnetosphere boundary are discussed. Other topics discussed are: (1) diffusion phe-

nomena, (2) gyroresonance phenomena, and (3) the reconnection model. (M.O.W.)

44270 INFLATION OF THE INNER MAGNETOSPHERE. Cahill, Laurence J. Jr. (Univ. of Minnesota, Minneapolis). pp 263-70 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Observations of the Earth's magnetic field during the April 17, 1965 storm are reported and described. Also, measurements from the June 15, 1965 storm are presented. (M.O.W.)

44271 RECENT OBSERVATIONS OF LOW-ENERGY CHARGED PARTICLES IN THE EARTH'S MAGNETOSPHERE. Frank, L. A. (Univ. of Iowa, Iowa City). pp 271-89 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Several recent observations of low-energy proton and electron intensities within the energy range ~100 eV to 50 keV in the earth's radiation zones with a sensitive array of electrostatic analyzers borne on the earth-satellite OGO 3 during mid-1966 are summarized. Measurements of charged particles of the extraterrestrial ring current during a moderate geomagnetic storm, of the low-energy proton and electron distributions in the vicinity of the midnight "trapping boundary" near the magnetic equatorial plane, and of upper limits for proton and ion (100 eV $\leq$ E/Q $\leq$ 50 keV) energy fluxes deep within the inner radiation zone are presented together with several introductory comments concerning the morphology of the omnidirectional intensities of energetic electrons (E $\geq$ 40 keV, $\geq$230 keV, and $\geq$1.6 MeV) at the magnetic equator in the outer radiation zone. (auth)

44272 MAGNETIC ENERGY RELATIONSHIPS IN THE MAGNETOSPHERE. Carovillano, Robert L. (Boston Coll., Chestnut Hill, Mass.); Maguire, John J. pp 290-300 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, SpRINGER-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Using a more physical method of calculating magnetic energy changes, various theorems relating to geomagnetic processes have been reformulated. In particular, the following was determined: (a) the energy of confinement of a magnetic dipole field by a perfectly conducting surface (e.g., the steady-state containment of the Earth's field by the solar wind); (b) the energy of transient compression of a shielded dipole field by a diamagnetic medium (such as the sudden commencement of a magnetic storm); and (c) the zero-order energy of trapped particles in an undistorted dipole field (e.g., the energy of the radiation belts during quiet times or the main phase in a weak magnetic storm). In all three instances the magnetic and kinetic energies are directly proportional to $M \cdot b(0)$, where b(0) is the total perturbation field at the position of the dipole moment M due to sources exterior to the shielding volume (if any). A new result shows that (c) follows directly from a more general theorem which phenomenologically includes the nonlinear effects of particle interactions within the belt. A simple model is developed which demonstrates that the zero order theorem (c) leads to an overestimate of the kinetic energy of the particle distribution when the nonlinear magnetic distortions of the particles are important. (auth)

44273 EXTERNAL AERODYNAMICS OF THE MAGNETOSPHERE. Spreiter, John R.; Alksne, Alberta Y.; Summers, Audrey L. (Ames Research Center, Moffett Field, Calif.). pp 301-75 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Topics discussed are: (1) the solar wind, (2) mathematical representation of the interaction of the solar wind and the geomagnetic field, (3) shape of the magnetospheric boundary, (4) flow around the magnetosphere, (5) microscopic interpretation of continuum results, (6) evaluation of theory and comparison with laboratory observations, (7) comparison with observations in space, (8) summary of steady aspects of the interaction of the solar wind with the geomagnetic field, and (9) unsteady aspects. (M.O.W.)

44274 OBSERVATIONS OF THE SOLAR WIND, BOW SHOCK, AND MAGNETOSHEATH BY THE VELA SATELLITES. Strong, I. B. (Los Alamos Scientific Lab., N. Mex.). pp 376-91 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Measurements are presented of the solar wind. Frequency distribution of azimuthal temperature is given. Velocity measurements are also given. (M.O.W.)

44275 REVIEW AND INTERPRETATION OF PARTICLE MEASUREMENTS MADE BY THE VELA SATELLITES IN THE MAGNETOTAIL. Hones, Edward W. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 392-408 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Vela satellite measurements of electrons in the magnetotail have shown that a thick sheet or slab of enhanced plasma stretches across the tail from the dusk to the dawn magnetopause. This plasma sheet near the midnight meridian at ~17 R_E often has a thickness of 4 to 6 R_E, although part of the measured thickness may result from plasma-sheet motion or configuration changes while the sheet is traversed. The sheet flares out in thickness by about a factor of 2 toward the dawn and dusk boundaries. Inside the plasma sheet the densities of electrons with energies above 350 eV range from below 0.1 cm^3 to ~1 cm^{-3}. Outside, in the magnetotail at high latitudes, the electron densities and/or energies are too low to be measured with the Vela analyzers. The average energy of the analyzer electrons near the equatorial plane of the plasma sheet is about 1 keV and falls off to ~0.5 keV near the upper and lower edges. The average energy of these electrons seems to be essentially independent of magnetospheric longitude. The energy density of the analyzer electrons is greatest at the magnetospheric equator near the dawn and dusk boundaries of the plasma sheet. Here the average values are about 300 eV/cm^3. The pattern of electron-energy densities appears symmetrical with respect to the midnight meridian. Despite the symmetry of the analyzer electron properties with respect to the midnight meridian, the >45-keV electrons display a strong dawn-dusk asymmetry, being observed much more frequently in the post-midnight region of the plasma sheet. The plasma sheet has been observed at all geocentric distances probed by the Vela satellites from 15.5 to 20.5 R_E. It seems reasonable to conclude that the plasma sheet extends from near the termination of the Van Allen radiation belt on the night side of the earth to beyond 31 R_E, to include those regions in which Anderson (1965) has observed energetic electrons. Variation in individual time histories of passes through the plasma sheet shows that the boundaries are not completely fixed. The sheet seems to be frequently in motion, probably in response to solar wind changes and in response to the diurnal wobble of the geomagnetic dipole. Also, boundary motions and variations of the internal characteristics of the plasma sheet are associated with magnetic-bay activity in the auroral zone. The plasma sheet becomes thinner and contains lower energy electrons as a magnetic bay develops. It then thickens and contains hotter electrons following the peak of the bay. (auth)

44276 SATELLITE STUDIES OF THE EARTH'S MAGNETIC TAIL. Behannon, Kenneth W.; Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.). pp 409-34 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Experiments on the structure, temporal behavior, shape, and length of the magnetic tail are described. Data from the IMP satellites are included. (M.O.W.)

44277 REVIEW OF AMES RESEARCH CENTER PLASMA-PROBE RESULTS FROM PIONEERS 6 AND 7. Wolfe, J. H.; McKibbin, D. D. (Ames Research Center, Moffett Field, Calif.). pp 435-60 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Two unique results obtained from the Pioneer missions are discussed. The first concerns the observation made by Pioneer 66 during the unusually quiet transit of the magnetosheath near the evening meridian. Pioneer 6, launched on December 16, 1965, traversed the magnetosheath near local sunset a few degrees below the ecliptic plane. At this time, interplanetary conditions, as determined by subsequent flight data, were extremely quiet with $A_p \approx 0$. The data revealed a density spike associated with the shock front and a density increase of approximately a factor of 3 as the flow crosses the shock. The density increases in the spike itself by over an order of magnitude above the free-stream value. The solar-wind electrons appear to increase in temperature by approximately a factor of 4 at the shock front and subsequently cool by about a factor of 2 as the flow proceeds downstream. The solar wind ions, on the other hand, although also heated to approximately the same extent as the electrons in the

vicinity of the shock front, do not appear to cool downstream and, in addition, reveal nonthermal characteristics. The data also indicate that 100-eV electrons may be injected into magnetosphere at the earth's magnetic field boundary and undergo further heating in the outer part of the magnetosphere. The second result discussed involves a preliminary account of what is presumed to be geomagnetic-tail-associated phenomena observed by Pioneer 7 at a distance of ~1000 R_E downstream from the earth. The interplanetary spacecraft, Pioneer 7, launched August 17, 1966, had an outward trajectory that passed through the sun–earth line 36 days after launch at a distance of ~820 R_E downstream from the earth. Three days subsequent to this time the plasma probe revealed anomalous plasma characteristics which continued intermittently for about 6 days and which have been tentatively identified with the effects of an extended magnetospheric tail. Preliminary data are presented which verify the nonradial flow of the solar wind and reveal a high degree of gross motion of the magnetospheric tail at these large distances. Comparison of plasma energy and angular distributions indicate the presence of plasma fluctuations within the frequency range 0.1 to 10 Hz. Although the data presented do not warrant the explicit application of any known theoretical tail structure at this distance, the results are discussed with regard to those phenomena which shed light on several possible models. (auth)

44278 THE GEOMAGNETIC TAIL: TOPOLOGY, RECONNECTION, AND INTERACTION WITH THE MOON. Sonett, C. P.; Colburn, D. S.; Currie, R. G.; Mihalov, J. D. (Ames Research Center, Moffett Field, Calif.). pp 461-84 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

A preliminary assessment of the geometry of the geomagnetic tail is made using data from the Ames magnetometer on the Explorer 33 satellite. The general shape corresponds to the earlier findings of Ness and coworkers. The tail is found regular to distances greater than 82 R_E. The field values vary for $K_p \leq 2+$ from a low of about 4 gamma to a high value of 40 gamma. Generally the values are in the neighborhood of 10 to 20 gamma. A distinct skewing of the field lines away from the solar-antisolar direction is observed, such that an added component of magnetic field in the direction of planetary motion is present on both sides of the null plane. The skewing appears to be greatest near the null plane. Increase in field magnitude with increasing K_p is observed. The radial gradient can be shown to fit a power or exponential law with near equal validity. A correlation analysis of field magnitude with radial distance, a_p, and transverse position coordinates also is discussed. Little cross gradient is observed in the tail field. Strong evidence for reconnection of field lines is found, and statistics are presented for a dual effect regarding the residual Z field across the null plane. Lastly the interaction of the tail field with the moon is discussed in terms of the mechanism of Sonett and Colburn. (auth)

44279 MAGNETIC TURBULENCE IN SHOCKS. Kennel, Charles F. (Univ. of California, Los Angeles); Petschek, Harry E. pp 485-513 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Two different theories for collisionless shock waves in plasma are discussed. Alfven shocks and whistler shocks are then discussed in detail. (M.O.W.)

44280 CYCLOTRON- AND BOUNCE-RESONANCE SCATTERING OF ELECTRONS TRAPPED IN THE EARTH'S MAGNETIC FIELD. Roberts, Charles S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 514-33 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Pitch-angle diffusion into the loss cone is an important loss mechanism for radiation-zone electrons trapped in the magnetosphere. This paper examines two wave-particle interactions which are likely to be important for producing pitch-angle scattering. These are cyclotron-resonance scattering by whistler-mode disturbances and bounce-resonance scattering by disturbances having electric- or magnetic-field components parallel to the earth's magnetic field. Both mechanisms can operate effectively not only with sinusoidally varying disturbance fields but also with irregular, noise-like field fluctuations. The latter have rather wide-band power-spectral-density functions, and the strength of the scattering is proportional to the power present at the frequency appropriate to produce either cyclotron or bounce resonance. Irregular whistler-mode disturbances with r.m.s. magnetic-field fluctuations of order $10^{-3}\gamma$ or higher are significant in producing rates of pitch-angle diffusion in agreement with observed electron lifetimes in the slot and outer electron zone. If the whistler-mode power-spectral-density function decreases rapidly with increasing frequency, then this mechanism may have difficulty in explaining the pitch-angle scattering of nearly equatorially mirroring electrons. Contributions from bounce-resonance scattering can also be significant for the pitch-angle diffusion of relativistic electrons. This requires irregular parallel electric-field fluctuations of order 0.01 to 0.1 V/km r.m.s. or magnetic-intensity fluctuations of order 10^{-5} to 10^{-4} r.m.s. of the earth's magnetic intensity at the equator of the line of force of interest. The experimentally observed loss of radiation-zone electrons may actually be due to a combination of the two mechanisms, bounce resonance being more important for electrons mirroring near the magnetic equator and cyclotron resonance being dominant for electrons mirroring sufficiently far off the magnetic equator. (auth)

44281 PENETRATION OF AURORAL ELECTRONS INTO THE ATMOSPHERE. Walt, Martin; MacDonald, William M.; Francis, William E. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). pp 534-55 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Simultaneously measured auroral phenomena were analyzed to ascertain whether the penetration of electrons into the atmosphere could be entirely understood on the basis of independent particle motion of the electrons. At present, the best data for comparing theory and experiment are the angular distributions and energy spectra of auroral electrons measured just above the atmosphere. It was seen that in most cases the theory is adequate, and these cases include the most consistent, steady-state data available. However, there are a significant number of cases in which more electrons are reflected than expected, and although there are several possible explanations the phenomena are not understood at present. (auth)

44282 ENERGY TRANSFER TO AND THROUGH IONOSPHERIC ELECTRONS. Carleton, N. P. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.). pp 556-62 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

The transfer of energy through ionospheric electrons is described by the following: (1) the degradation of fast electrons (photoelectrons or precipitated particles) and (2) the flow of electric currents. (M.O.W.)

44283 MAGNETOSPHERIC AND HIGH LATITUDE IONOSPHERIC DISTURBANCE PHENOMENA. Brice, Neil (Cornell Univ., Ithaca, N. Y.). pp 563-85 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

The average behavior of magnetospheric and high-latitude ionospheric disturbance phenomena is discussed. Relevant observational data are interrelated through consideration of the bulk motion flow pattern of the magnetosphere and the associated electric field distribution. The characteristic temporal modulation of the average distribution pattern is also discussed. (M.O.W.)

44284 PARTICLE DYNAMICS AT THE SYNCHRONOUS ORBIT. Freeman, J. W. Jr.; Maguire, J. J. (Rice Univ., Houston, Tex.). pp 586-604 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

A low-energy charged-particle detector was flown aboard the geostationary ATS-1 satellite. A preliminary study of the data revealed large local time variations in the particle fluxes observed during geomagnetically disturbed times. The salient features of the observed variations are: (1) During periods of moderate magnetic activity a high particle flux is seen near local midnight. This flux shows a strong pre/post-midnight asymmetry with the particle intensities being higher in midnight-to-dawn quadrant. (2) During periods of high magnetic activity the enhanced particle flux distribution broadens out in local time to cover a large fraction of the night-side portion of the synchronous orbit. The pre/post-midnight asymmetry is generally still present but less striking. (3) During periods of enhanced magnetic activity the local time distribution of the particle fluxes shows a

remarkable similarity to the local time distribution of high-latitude magnetic substorm activity. It is suggested that the observed particle distribution is indicative of an influx of energetic plasma from the magnetospheric tail. Implications-relating to magnetic storm models are discussed. The worldwide magnetic storm of January 13–14, 1967 is analyzed. Data are presented which indicates a magnetospheric boundary crossing and the anisotropic injection of a cloud of monoenergetic protons. It is suggested that this localized plasma cloud maintains its identity through at least three longitudinal drift periods. (auth)

44285 SHOCK AND MAGNETOPAUSE BOUNDARY OBSERVATIONS WITH IMP-2. Binsack, Joseph H. (Massachusetts Inst. of Tech., Cambridge). pp 605-21 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

The data from the M.I.T. plasma experiment on IMP-2 have shown that the boundaries of the magnetosheath are extremely pliable and responsive to solar and geomagnetic activity. Further, even during relatively quiet periods, the boundaries appear to remain in motion although on a smaller scale. Both long-term (hours) and short-term (minutes) periodicities have been observed. The actual shock boundary layer was observed, and rapidly varying fluxes in energy and direction are characteristic of the layer. (auth)

44286 LOW-ENERGY ELECTRONS IN THE MAGNETOSPHERE AS OBSERVED BY OGO-1 AND OGO-3. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). pp 622-40 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Electron measurements were made in the 40-eV to 2-keV range with a Faraday cup. The general configuration of the plasma sheet is described. The termination of the plasma sheet on the earthward side and its relation to magnetic-bay activity are described in some detail. (M.O.W.)

44287 SUMMARY OF EXPERIMENTAL RESULTS FROM M.I.T. DETECTOR ON IMP-1. Olbert, Stanislaw (Massachusetts Inst. of Tech., Cambridge). pp 641-59 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

Measurements of electric currents taken in the magnetosheath by the IMP-1 satellite are presented. Solar wind velocity measurements are also given. (M.O.W.)

44288 CHARGED PARTICLE DIFFUSION BY VIOLATION OF THE THIRD ADIABATIC INVARIANT. Birmingham, T. J. (Goddard Space Flight Center, Greenbelt, Md.); Northrop, T. G.; Faelthammar, C.-G. pp 660-77 of Physics of the Magnetosphere. Carovillano, Robert L. (ed.). New York, Springer-Verlag New York Inc., 1968.

From Conference on Physics of the Magnetosphere, Chestnut Hill, Mass. See CONF-670662.

An equation which describes statistically the motion of charged particles in response to fluctuating electric and magnetic fields is derived. The particles are assumed to be moving in a mirror-type magnetic geometry. In addition to a static magnetic field there are small superposed fields fluctuating randomly on such a time scale that the first and second adiabatic invariants, M and J, are conserved, but the third or flux invariant, ϕ, is violated. By using second adiabatic theory a two-dimensional diffusion equation is obtained, valid on a much longer time scale than that of the fluctuations. Elements of the diffusion tensor are time–space correlations of fluctuation-induced perturbations in the guiding-center drifts. These drift perturbations are systematically derived and shown to reduce simply in various special cases. (auth)

44289 HIGHER ORDER RESONANCES IN A MAGNETOPLASMA. Chen, C. S.; Lewak, G. J. (Univ. of California, San Diego La Jolla). J. Geophys. Res., 74: 4765-71(Sept. 1, 1969).

Using perturbation theory analysis of a two-grid source in a magnetized Vlasov plasma, it is shown that the plasma responds resonantly when the source frequency is $2\Omega/p$, or ω_H/p, (p integer) where Ω and ω_H are the gyro and upper hybrid frequencies. It is further shown that as a resonant frequency is approached from below, the asymptotic solution represents a wave whose group and phase velocities are in opposite directions, whereas, if it is approached from above, the solution is a wave with group and phase velocities in the same direction. These fractional resonances are tentatively identified with those seen in Alouette 2 topside sounder data. A nonlinear mechanism is proposed to explain the observability of these resonances. (auth)

44290 FORBIDDEN TRANSITIONS IN THE UPPER ATMOSPHERE. Roach, F. E. (Battelle-Northwest Labs., Richland, Wash.). Mem. Soc. Roy. Sci. Liege, (5), 17: 175-85(1969).

From 15th International Conference on Astrophysics, Liege, Belgium. See CONF-680658.

Mechanisms of excitation and de-excitation of atoms and molecules in the upper atmosphere are reviewed. Forbidden atomic emissions and molecular band systems observed in the upper atmosphere are summarized in tables. (A.G.W.)

44291 HIGH-FREQUENCY MAGNETIC FLUCTUATIONS ASSOCIATED WITH THE EARTH'S BOW SHOCK. Olson, John V. (Univ. of California, Los Angeles); Holzer, Robert E.; Smith, Edward J. J. Geophys. Res., 74: 4601-17(Sept. 1, 1969).

Magnetic fluctuations associated with the earth's bow shock in the frequency range 0.5 to 500 Hz were detected with the search coil magnetometer on OGO 3. The shock crossings analyzed here represent data taken at the 64,000-bit/sec data rate, where the instrument Nyquist frequency is approximately 140 Hz. Power spectra have been computed for various intervals in the shock and show a broad band of noise to be present, which is of two basic types. First there is a random background of frequencies that cover a range from below one to many hundreds of hertz. Superimposed upon this background are short-lived packets of coherent elliptically polarized radiation that occur randomly at frequencies from 10 to 500 Hz and range in amplitude from 0.01 to 0.1 γ. Each packet is nearly monochromatic. The spectra computed from these data vary with position in the shock and are more than 2 orders of magnitude above interplanetary medium spectra and generally more than 1 order of magnitude above the magnetosheath spectra. All spectra fall nearly as $1/f^3$ above 10 Hz, whereas the shock spectrum tends to peak below 10 Hz. The total energy density contained in these fluctuations is of the order of 4.3×10^{-11} erg/cm^3, or about 1% of the total solar-wind energy density in the shock frame. (auth)

44292 FAST TEMPORAL AND SPATIAL CHANGES IN AURORAS. Cresswell, George Robert. College, Alaska, Univ. of Alaska, 1968. 189p.

Thesis.

Several types of pulsing and fast-moving auroras were examined with photometers and television systems. Pulsating auroras were seen to be restricted primarily to the equatorward boundary of the auroral display in the midnight and morning sectors following substorm onsets. Flaming auroras appear to occur under the same conditions as pulsating auroras and, in fact, pulsating auroras have sometimes been observed to flame. Flickering auroras were occasionally observed as part of bright discrete features seen before midnight on active days. They were made up of numerous small patches, 1 to 2 km across, each of which underwent rapid (~10 cps) changes of size, shape, and intensity. Fast auroral waves are east–west aligned, arc-like features that were seen to propagate southward at 50 to 300 km/sec and at about once per second in the College vicinity after midnight. They occurred only when the preceding daylight hours, and often the evening hours, were magnetically undisturbed, and always after a short-lived (1 to 2 hour) substorm. It is suggested that the waves are due to hydromagnetic processes occurring near the equatorial plane that provide electrons in the loss cone. The hydromagnetic velocity across the field lines there projects down to the atmosphere to give velocities in the observed fast auroral wave velocity range. (Diss. Abstr.) (TSS)

44293 GLOBAL ELECTRON DENSITY DISTRIBUTIONS FROM TOPSIDE SOUNDINGS. Chan, K. L.; Colin, Lawrence (Ames Research Center, Moffet Field, Calif.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 990-1004(June 1969).

A global morphology of electron density distributions in the topside ionosphere during sunspot minimum as deduced from Alouette I and II ionograms is presented. Graphs are shown illustrating the variations of electron density with altitude (400 to 3000 km), dip latitude (±90°), local time (24 hours), and season (December and June solstices; equinox) for both quiet and disturbed geomagnetic field conditions. "Average" daytime and nighttime electron density distributions, based on the analysis of large quantities of Alouette I quiet-time data, are presented for the lower altitudes (less than 1000 km) and for low and middle dip latitudes for each season. Large-scale anomalous features are summarized and discussed with respect to their bottomside counterparts where such exist. Small-scale effects and physical explanations for the topside ionosphere behavior are discussed in companion papers. (auth)

44294 HIGH-LATITUDE IONOSPHERE. Jelly, D. H.; Petrie, L. E. (Communications Research Center, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1005-12(June 1969).

Information on the high-latitude ionosphere derived from the Alouette-ISIS program is reviewed. It is primarily descriptive and deals mainly with F-region features. Particle effects in the D region and night E ionization are briefly considered. F-region features include the main trough, maxima and minima in electron density in the polar region, and electron-density irregularities revealed by the presence of spread echoes on topside ionograms. The relationship of these features to the plasmapause and the energetic particle boundaries is discussed. Although ionization effects in the D region are not directly detectable by the Alouette satellites, large increases in D-region ionization are produced at high latitudes by the influx of energetic particles which may be detected by some of the energetic particle counters on board. For both polar-cap and auroral events, empirical relations have been derived between particle fluxes and D-region radio-wave absorption measured by riometers. (auth)

44295 REVIEW OF TOPSIDE SOUNDER STUDIES OF THE EQUATORIAL IONOSPHERE. Eccles; D.; King, J. W. (Radio and Space Research Station, Slough, Eng.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1012-18(June 1969).

The structure of the equatorial ionosphere as derived from topside sounder data is reviewed. Shortly after sunrise a single ionization crest occurs above the magnetic equator at all heights, but later during the day an equatorial anomaly develops in the form of an arch along which the ionization is enhanced and which lies along different magnetic field lines at different local times. The arch intersects the F2-layer peak at the latitudes where the well-known equatorial anomaly crests occur. The anomaly develops after about 0800 LMT in the Asian sector, but there is some evidence which suggests that the anomaly may start to develop several hours later in the American sector. The anomaly starts to decay after about 1500 LMT in the Asian sector, but only after about 2000 LMT in the American sector. The behavior during this decay phase, however, has not yet been fully established. During the night hours marked spread-F echoes are observed on the low-latitude topside sounder ionograms. (auth)

44296 IONOSPHERIC IRREGULARITIES OBSERVED BY TOPSIDE SOUNDERS. Calvert, W.; Warnock, J. M. (Environmental Science Services Administration Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1019-25 (June 1969).

Topside sounders observe electron-density irregularities in the ionosphere with dimensions of hundreds of meters to many kilometers across the magnetic field. Most irregularities are elongated and may extend thousands of kilometers along the field. The variation of electron density is normally a few percent or less. The irregularities tend to occur in patches, in which the individual irregularities vary greatly in size. Irregularities can produce radio echoes by scattering, ducting, or complex refraction, depending on their dimensions. The different kinds of echoes produce different characteristic patterns on topside ionograms, and therefore irregularities in various size ranges may be distinguished and studied. (auth)

44297 ON THE PREDICTION OF F-LAYER PENETRATION FREQUENCIES. Petrie, L. E.; Lockwood, G. E. K. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1025-8(June 1969).

The Comite Consultatif International des Radiocommunications (C.C.I.R.) predictions of F-layer penetration frequencies have been compared with 1963 Alouette topside-sounder data. The data used for these comparisons were collected from 45° to 165°W longitude in the northern hemisphere. It was found that the C.C.I.R predictions differ by as much as 0.7 MHz from the Alouette data. The latitudinal and longitudinal variations could be represented more accurately in the C.C.I.R. prediction system by supplementing the ground-based ionosonde data with topside-sounder data. (auth)

44298 TOPSIDE IONOSPHERE DURING GEOMAGNETIC STORMS. Warren, E. S. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1029-36 (June 1969).

The state of knowledge of ionospheric storms in the topside ionosphere is reviewed. Although much remains to be understood concerning ionospheric storms, many of the storm-time phenomena can be interpreted in terms of drift motions produced by storm-time currents, and by ambipolar diffusion. (auth)

44299 IONOSPHERIC ION COMPOSITION DEDUCED FROM VLF OBSERVATIONS. Barrington, R. E. (Communication Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1036-41(June 1969).

Very low frequency observations from the Alouette satellites have provided information on the ion composition of the ionosphere. This is derived from two sources: noise bands with a lower frequency cutoff at the lower hybrid resonance (LHR) frequency, and ion whistlers. The LHR frequency depends on the harmonic mean mass of the ionic constituents. Ion whistlers provide good measurements of the relative abundances of protons and helium ions, as well as the proton density and on occasion, proton temperatures. (auth)

44300 RADIO NOISE LEVELS WITHIN AND ABOVE THE IONOSPHERE. Hartz, T. R. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1042-50(June 1969).

The principal results obtained from the background noise experiment in the Alouette satellites are summarized. The various natural emissions, most of which can reach intensity levels as high as 80 dB above receiver threshold, are identified in the recordings with reference to the characteristic frequencies of the ionosphere local to the spacecraft and are described in turn. Galactic noise is the predominant signal above f_T, with some occasional solar noise contributions; emissions are described and values are presented for the galactic spectrum between 0.6 and 12 MHz. Below f_T, four distinct ionospheric emissions are recognized and tentatively associated with plasma processes. They are (1) a noise band below f_H which is thought to result from cyclotron emission from energetic electrons, (2) a band that occurs mainly between f_H and f_7S and which probably results from a spacecraft interaction with the local plasma, (3) a noise band between f_7S and f_T which is believed to result from transverse electrostatic oscillations, and (4) a band at frequencies above f_N which probably results from longitudinal electrostatic oscillations in the ionosphere. These ionospheric emissions show an association with ionization irregularities; at times, also, overtones and intermodulation products of such emissions can be clearly recognized at frequencies above f_T. (auth)

44301 HIGH-LATITUDE LIMIT OF CLOSED GEOMAGNETIC FIELD LINES. Burrows, J. R.; McDiarmid, I. B.; Wilson, Margaret D. (National Research Council of Canada, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1051-3(June 1969).

One of the investigations carried out with the energetic particle experiment on the Alouette satellites has been a study of the high-latitude boundary of 35-keV electrons in the outer radiation zone. A comparison of Λ_b, the average high-latitude boundary, with solar proton intensity versus latitude profiles, and with the location of the auroral oval, leads to the conclusion that Λ_b indicates approximately the high-latitude limit of closed geomagnetic field lines, or alternatively the low-latitude limit of open field lines. The dependence of Λ_b on local magnetic time and on the angle ϕ between the earth–sun line and the geomagnetic axis has been investigated. A noon–midnight asymmetry of about 8° is observed in Λ_b as well as a marked dawn–dusk asymmetry. A dependence of Λ_b on ϕ is also observed, in which Λ_b has a minimum for $\phi \sim 90°$ and is approximately symmetrical about this angle. The results are interpreted as indicating a stronger coupling between the solar wind and the magnetosphere when $\phi \sim 90°$, which results in more geomagnetic flux being swept back into the "tail" at these times. Some of the information included is presented in more detail in a recent paper by McDiarmid and Wilson [J. Geophys. Res. 73: 7237 (1968)]. (auth)

44302 THERMAL ION AND ELECTRON TRAP EXPERIMENTS ON THE EXPLORER XXXI SATELLITE. Donley, John L. (Goddard Space Flight Center, Greenbelt, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1061-3(June 1969).

The planar thermal ion and electron trap experiments on the Explorer XXXI satellite are described. These are capable of measuring ion and electron density and temperature and ionic composition at the satellite. Instrumentation, principles of operation, data analysis procedures, and sources of error are discussed. (auth)

44303 ION MASS SPECTROMETER ON EXPLORER XXXI SATELLITE. Hoffman, John H. (Naval Research Lab., Washington, D. C.) Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1063-7 (June 1969).

A magnetic sector field mass spectrometer on the Explorer XXXI satellite, when calibrated in flight against electron concentration data from the Alouette II topside sounder satellite, measures the absolute concentrations of the various positive ion species in the ionosphere. The in-flight calibration is performed by comparing the total ion current measured by the mass spectrometer, corrected for internal discriminations, with the electron concentrations, first in regions of nearly pure H^+, then in regions of nearly pure O^-, to obtain calibration coefficients for each ion species. Data at 500 km show as many as ten different ion species in the ionosphere. Over the polar region, H^+ ions streaming upward at 10 to 15 km/s have been observed. (auth)

44304 EXPLORER XXXI TOTAL CURRENT MONITOR EXPERIMENTS. Maier, E. J. R. (Goddard Space Flight Cen-

ter, Greenbelt, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1068-71(June 1969).

The suprathermal electron flux was measured by means of retarding-potential analyzers on Explorer XXXI. Samples of various types of data are presented and some of the analysis procedures are discussed. Detailed analyses of particle flux measurements obtained in the energy range 7 to 200 eV are presented for the data from three spacecraft transits of the polar region. The integral flux and derived differential velocity distributions yield the result that in the polar trough region there is an enhanced energy density of the suprathermal particles, with a value comparable to that of the ambient thermal plasma. At lower latitudes, the pressure of suprathermal particles is significantly less than that of the thermal plasma. (auth)

44305 LANGMUIR PLATE AND SPHERICAL ION PROBE EXPERIMENTS ABOARD EXPLORER XXXI. Wrenn, Gordon L. (University Coll., London). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1072-7(June 1969).

Two probe experiments aboard Explorer XXXI measure the concentrations and temperatures of the thermal electrons and major ion species encountered by the satellite. A brief description of the instruments is given and examples of data are presented to illustrate special features which could be relevant when contrasting results with those from other experiments on Explorer XXXI or Alouette II. Comparison with data from the ionosonde aboard the latter provided information on the effective collecting area of the probes and the influence of the plasma sheath surrounding the satellite. (auth)

44306 COMPARISON OF RESULTS OF EXPLORER XXXI DIRECT MEASUREMENT PROBES. Donley, J. L. (Goddard Space Flight Center, Greenbelt, Md.); Brace, L. H.; Findlay, J. A.; Hoffman, John H.; Wrenn, Gordon L. Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1078-84(June 1969).

Intercomparison measurements of the major ionospheric parameters of ion and electron density and temperature and ionic species made by direct measurement probes on the Explorer XXXI satellite are presented. Plasma density results are compared with simultaneous data from the Alouette II satellite. Probe results are from the following experiments: planar ion trap, planar electron trap, cylindrical electrostatic probes, high-resolution magnetic ion mass spectrometer, planar Langmuir plate, and spherical ion probe. The plasma densities measured by the various probes generally agree with simultaneous Alouette II sounder values to within 20%. Electron temperatures measured by three different types of probes generally agree within 10%. Ion composition measurements by the planar ion trap and spherical probe show good agreement with the high-resolution magnetic mass spectrometer. Ion temperature measurements from the ion trap are consistently higher than spherical ion probe results. (auth)

44307 RESULTS DERIVED FROM SIMULTANEOUS MEASUREMENTS USING THE LANGMUIR PLATE AND SPHERICAL ION PROBE ON EXPLORER XXXI AND THE IONOSONDE ON ALOUETTE II. Wrenn, G. L. (University Coll., London); Smith, P. A. Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1085-9(June 1969).

Measurements of electron temperature, ion concentration, and ion temperature obtained by means of the Langmuir plate and spherical ion probe on the Explorer XXXI satellite are presented together with results obtained at the same time from the Alouette II ionosonde for a period when the two satellites were close together. Electron concentration measurements by the sounder have been used for in-flight calibration of the probe total positive ion concentration measurements, and an effective grid transparency for the probe was obtained. This transparency, which appears to be different for different ion species, was 35% for hydrogen ions and 42% for oxygen ions. Results from a set of measurements centered on a latitude near 70° magnetic dip in the Australasian region are tabulated and have been used to determine vertical temperature gradients of the plasma on the basis of diffusive equilibrium theory. The calculated gradients are negative between altitudes of 650 and 1050 km. The reality of these negative gradients cannot be confirmed because the direct measurements of plasma temperature exhibit large day-to-day fluctuations so that a reliable height variation of temperature cannot be constructed. (auth)

44308 TOPSIDE-SOUNDER RESONANCES. Calvert, W.; McAfee, J. R. (ESSA Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1089-96(June 1969).

The plasma resonances observed by topside sounder satellites appear as persistent ringing signals at the plasma frequency and at multiples of the electron-cyclotron and upper hybrid frequencies. They are attributed to slow, electrostatic waves which occur near these frequencies. Explanations have progressed from invoking stationary waves or waves moving with the satellite to invoking waves which are reflected back to the satellite by the vertical electron-density gradient. In addition to the principal resonances, plasma echoes, proton-period modulation, lower frequency resonant signals and "floating" resonances are also observed. (auth)

44309 NONVERTICAL PROPAGATION AND DELAYED-ECHO GENERATION OBSERVED BY THE TOPSIDE SOUNDERS. Muldrew, D. B. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1097-1107(June 1969).

Knowledge of the topside ionosphere resulting from studies of nonvertical propagation, such as scatter from ionization irregularities and minitroughs, hemispherically conjugate echoes, combination modes, multiple-hop propagation, unusual Z-wave propagation, and whistler-mode propagation, is reviewed. From these studies there appear to be two major types of magnetic field-aligned ionization irregularities: a thick and a thin type. The thick type has a thickness of tens or hundreds of kilometers and occurs both near the auroral zone and at latitudes corresponding to the equatorial anomaly. The thin type has a thickness of a few hundred meters and may extend thousands of kilometers along a field line. At high latitudes, the thin type has a tubular cross section, may have an electron density either greater or less than the ambient, and may result from fluxes of energetic particles; at low latitudes, the thin type has an electron density deviation of the order of 1%. The thin type of ionization irregularity supports propagation which is responsible, at some distance from the satellite, for two different delayed-echo phenomena. In the vicinity of the satellite, electrostatic waves with near-zero group velocity are probably responsible for the f_H, F_T, and nf_H resonance spikes and also for the newly discovered f_{Qn} resonance spikes which occur at nonzero and noninfinite values of the wave number. A novel spike, called the "floating spike," is believed to result from propagating electrostatic waves. (auth)

44310 NONLINEAR PLASMA EFFECTS IN THE ALOUETTE RECORDINGS. Hartz, T. R.; Barrington, R. E. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1108-13(June 1969).

Recordings from the ionosonde receivers in the Alouette II satellite commonly show narrow-band, resonant-like signals at frequencies below the fundamental ionospheric resonances, f_L, f_N, and f_T. These are attributed to nonlinear processes in the plasma near the spacecraft, and the on-board electronic equipment; studies of these signals are reviewed. Particular attention is given to the subsidiary resonances, which appear at simple fractions of the ionospheric resonances. It is shown that an explanation involving harmonic stimulation of the plasma resonances and beat-frequency generation is consistent with most of the observations. Several other types of satellite data are also examined and further substantiation is found for nonlinear plasma behavior. The importance of ionospheric nonlinearities is discussed briefly for both transmission and reception of radio signals in space. (auth)

44311 DIFFUSIVE EQUILIBRIUM IN THE TOPSIDE IONOSPHERE. Bauer, S. J. (Goddard Space Flight Center, Greenbelt, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1114-18(June 1969).

Diffusive equilibrium is an idealized concept, representing a limiting case of the continuity equation for charged particles in the ionosphere. Since plasma diffusion can proceed rather rapidly above the F2 peak, the plasma density distribution in the topside ionosphere can, in general, be approximated by a diffusive equilibrium distribution. The density scale height of this distribution depends on the mean ionic mass (i.e., ion composition), and the electron and ion temperatures and their gradients. While diffusive equilibrium is reasonably representative of the distribution of plasma density (and therefore of the major ions), the distribution of the minor ions in the topside ionosphere may still be affected strongly by chemical and transport processes. Because of the magnetic field control of plasma diffusion, equilibrium conditions apply along magnetic field lines. At latitudes where the magnetic dip is fairly high ($I > 60°$), diffusive equilibrium applies directly to vertical density profiles. At high latitudes (beyond the "trough"), where the local plasma density can be very low, an almost "collisionless" regime prevails, leading to an "ion-exosphere" distribution, which decays with altitude much faster than a diffusive equilibrium distribution. Although diffusive equilibrium may not always be strictly applicable, the concept provides a readily available analytical model for the general features of the topside ionosphere. (auth)

44312 REVIEW OF THE THEORIES CONCERNING THE EQUATORIAL F2 REGION IONOSPHERE. Goldberg, Richard A. (Goddard Space Flight Center, Greenbelt, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1119-26(June 1969).

The most striking feature of the equatorial F-region ionosphere is the equatorial geomagnetic anomaly. This phenomenon has been known for nearly thirty years from bottomside measurements, but only recently have topside sounders provided sufficient data for the development of theoretical models. It appears that the major contribution to this effect lies in the interaction of the ionosphere with the earth's magnetic field via mechanisms causing drifts and currents. However, other theories have considered control due principally to production, loss and temperature effects. Relevant theoretical analyses are reviewed and the theoretical predictions are compared with data available from the Alouette I topside sounder. (auth)

44313 DAY–NIGHT VARIATION OF ALOUETTE II SECONDARY RESONANCES. Barry, J. Dale (Univ. of California, Los Angeles); Coleman, Paul J. Jr.; Libby, W. F.; Libby, L. Marshall. Contract AT(11-1)-1537. Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1126-8(June 1969).

A further analysis of the secondary resonances observed on Alouette II ionograms is reported. This analysis indicates a day–night effect in the relative frequency of occurrence. (auth)

44314 PROPERTIES OF HIGH-LATITUDE IONOSPHERIC DUCTS DEDUCED FROM ALOUETTE II TWO-HOP ECHOES. Muldrew, D. B.; Hagg, E. L. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1128-34 (June 1969).

Radio waves transmitted by the Alouette satellite can, after being reflected in the ionosphere, return to the satellite and be scattered from the satellite antennas. Some of the scattered energy will be reflected again in the ionosphere and return to the satellite, and may then be detected. From the strength of such "two-hop" signals, it is deduced that they propagate in field-aligned cylindrical ducts or tubes that have cross sectional areas of the order of 0.1 km^2 and electron densities less than the ambient plasma. The guiding of waves by these field-aligned tubes is considerably less efficient for the ordinary wave (O wave) than for the extraordinary wave (X wave). For example, it was found from a small sample of two-hop data that the single-hop O wave signal strength, at frequencies above the plasma frequency in the tube, was roughly 15 dB (quartile range: 10 to 26 dB) below the X wave signal strength. (auth)

44315 SIDEBAND STRUCTURE OBSERVED BY TOPSIDE SOUNDERS. Warnock, J. M. (ESSA Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1135-9 (June 1969).

Plasma wave features appearing on topside ionograms which occasionally exhibit structure due to the sidebands of the transmitted frequency spectrum include the O, X, Z, oblique-Z, and ducted traces; and plasma, electron-cyclotron, and electron-cyclotron harmonic resonances. The sidebands provide information on the nature of the features, aid in their identification, and improve the frequency and spatial resolution of the data. (auth)

44316 FREQUENCY SHIFTS OBSERVED IN THE ALOUETTE II CYCLOTRON HARMONIC PLASMA RESONANCES. Benson, Robert F. (Goddard Space Flight Center, Greenbelt, Md.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1139-42(June 1969).

The cyclotron harmonic plasma resonances observed by Alouette II were investigated using a technique that yielded frequency measurements with an accuracy of the order of 1 kHz. The resonances observed near f_H and $2f_H$ experience frequency shifts of the order of +2% and +0.5%, respectively, when $f_N/f_H \approx 3$ where f_N is the electron plasma frequency and f_H is the electron cyclotron frequency. The resonances observed above the upper hybrid frequency approach the true frequency values of nf_H as n increases; beyond about n = 5 the observed cyclotron harmonic resonant frequencies are consistent with a single value of f_H which agrees with model magnetic field calculations within the estimated 0.2% reliability of this field. The frequency shifts observed previously for these resonances on the Alouette I data are attributed to magnetic contamination from the Alouette I spring steel antennas. A comparison of the earlier Alouette I results with the present Alouette II results indicates that the bulk of the original excitation volume associated with the higher cyclotron harmonic resonances is confined to a region considerably less than one antenna length in radius from the antenna, that the size of this region decreases with increasing harmonic number n, and that it increases significantly as the radiating antenna becomes parallel to the direction of the earth's magnetic field. (auth)

44317 MODEL STUDIES OF THE KINKED Z TRACE IN TOPSIDE IONOGRAMS. Colin, Lawrence; Chan, K. L. (Ames Research Center, Moffett Field, Calif.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1143-7(June 1969).

The propagation characteristics of the Z trace observed on topside ionograms are reviewed. One feature, the "kinked" Z trace, is examined in detail. It is shown that the kink can be explained by simple magnetoionic theory and is not due to peculiar electron density distributions. A ray-tracing propagation analysis confirms this contention. Although the Z trace normally does not propagate down to the F-layer peak, its inherent resolution is superior to that of the ordinary and extraordinary modes. Its use in ionogram analysis may thus improve the accuracy of electron density profile calculations. (auth)

44318 MIDDLE-LATITUDE F REGION DURING SOME SEVERE IONOSPHERIC STORMS. Norton, R. B. (ESSA Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1147-9(June 1969).

Topside ionograms taken during some severe ionospheric storms show F2-layer critical frequencies that are less than F1-layer critical frequencies. A comparison of the electron density profiles derived from Alouette I ionograms obtained during these disturbed periods with those obtained during undisturbed periods shows that the height of the F2 layer moves up, the plasma scale height above the F2 peak increases, and the column electron content up to 1000 km decreases. Data taken during the April 18, 1965, storm are treated in detail and it is found that an increase in the electron loss rate by a factor of 16 times the undisturbed rate can account for the decrease in electron density. (auth)

44319 STRUCTURE OF THE TOPSIDE IONOSPHERE DEDUCED FROM ALOUETTE DATA. Matuura, Nobuo; Ondoh, Tadanori (Radio Research Labs., Tokyo). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1150-3(June 1969).

Alouette II topside sounding data were recorded at the Kashima station of the Radio Research Laboratories, Japan, and some preliminary results obtained from analysis of the topside sounding data during the one year period from October, 1966, to September, 1967, are reported. The plasma frequency at the satellite was determined from several characteristic frequencies of each topside ionogram obtained from Alouette II data. The average nighttime structure of the ionosphere was derived from plasma frequencies measured at various satellite positions over the data acquisition area of the Kashima station. The results are presented in terms of the electron-density distributions versus altitude and geomagnetic latitude. Some ionospheric parameters were determined by fitting theoretical electron-density profiles to the observations. Theoretical electron-density profiles obtained on the assumption of constant plasma temperature (average of the electron and the ion temperatures) were compared with those obtained for the case when the height gradient of the plasma temperature is put equal to 0.5°K km. The comparison shows that the difference in the theoretical electron-density profiles between the two cases is not too serious, and hence, the theoretical electron-density profiles for the constant plasma temperature model were used to determine the ionospheric parameters. The results show that the probable thermopause temperature (i.e., neutral particle temperature at the base of the exosphere which is assumed to lie at the 600-km level) varies from about 1000 to 1200°K in the lower-latitude region, to about 1500°K in the higher latitude region, and further, that the plasma temperature (assumed constant with altitude) varies from about 1000°K in the lower-latitude region to about 2500°K in the higher-latitude region. (auth)

44320 TEMPERATURE AND ION ABUNDANCE PROFILES DEDUCED FROM SIMULTANEOUS EXPLORER XXXI AND ALOUETTE II DATA. Colin, Lawrence; Dufour, Stuart W.; Willoughby, Dora S. (Ames Research Center, Moffett Field, Calif.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1154-8 (June 1969).

Field-aligned electron concentration profiles from the Alouette II sounder are combined with simultaneous measurements of ion and electron temperatures and relative ionic abundances measured by the Explorer XXXI satellite at its orbit to deduce plasma temperature ($(T_e + T_i)2$) and ion concentration profiles using a diffusive equilibrium theory. Analysis of eleven Alouette II–Explorer XXXI passes during December, 1965, and January, 1966, indicates that regions of constant or slightly decreasing plasma temperature with height are common in the lower exosphere. These results imply the presence of regions of negative or zero ion temperature gradients since experiment and theory generally yield nonnegative electron temperature gradients over the altitude range considered. The possibility of negative ion temperature gradients has been suggested. (auth)

44321 ALOUETTE OBSERVATIONS TAKEN DURING A MIDDLE-LATITUDE RED ARC. Norton, Richard B.; Marovich, E. (ESSA Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1158-60(June 1969).

A comparison of 6300 Å airglow data obtained at the Fritz Peak

Airglow Observatory with topside ionosonde data obtained with the Alouette satellites on September 29, 1967, indicates the presence of a field-aligned depression of electron density associated with middle-latitude auroral red arcs. The Alouette data also indicate that the plasma temperature along field lines intersecting the arc may be somewhat higher than in neighboring regions. Furthermore, the transition from dominant O^+ to dominant H^+ occurs at much higher altitudes on the field lines intersecting the arc. (auth)

44322 PRELIMINARY RESULTS OF COMPARISON BETWEEN THOMSON SCATTER AND TOPSIDE SOUNDER MEASUREMENTS. Taieb, C. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1161-3(June 1969).

Ionic compositions are derived by combining Alouette topside electron density profiles with electron and ion temperatures measured by the bistatic Thomson scatter sounder at St. Santin. Data from only four passes in 1967 are available, so that the results are still tentative. (auth)

44323 ELECTRON DENSITIES LESS THAN 100 ELECTRON cm^{-3} IN THE TOPSIDE IONOSPHERE. Timleck, P. L.; Nelms, G. L. (Communications Research Centre, Ottawa). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1164-71(June 1969).

Data obtained from Alouette II topside-sounder ionograms have been used to study the regions of occurrence of low electron number density, $N \leq 100$ electron cm^{-3}, from December 1965 to April 1968. The study investigates the diurnal, seasonal, and spatial variations in the height and frequency of occurrence of the low electron density regions below 3000 km, within the limits imposed by the Alouette II orbit. In the northern-hemisphere winter near sunspot minimum, low electron densities were observed at all local times. A few examples were found in the summer (northern hemisphere) but only for local times around midnight and in the region of the main (midlatitude) trough. Most of the low electron densities were observed at geomagnetic latitudes greater than 65° near noon and greater than 55° near midnight, although they were observed at geomagnetic latitudes as low as 45° in the southern hemisphere near midnight. The low height cutoff of occurrence of $N \leq 100$ electron cm^{-3} showed a diurnal variation, with heights of 1400 km at night and about 2400 km near noon. This diurnal effect shifted upward in height during years of increased solar activity. The observations are shown to be consistent with the removal of light ions over regions in which the magnetic field lines are swept back into the tail of the magnetosphere. (auth)

44324 CHARACTERISTICS OF POLAR CAP AURORAS. Eather, R. H. (Lockheed Palo Alto Research Lab., Calif.); Akasofu, Syun-I. J. Geophys. Res., 74: 4794-8(Sept. 1, 1969).

The structured luminosity and its characteristics in the polar cap are described in detail on the basis of material obtained during the NASA airborne survey across the polar cap. (M.O.W.)

44325 FAR INFRARED NIGHTGLOW EMISSION FROM ATOMIC OXYGEN. Feldman, P. D.; McNutt, D. P. (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 74: 4791-3(Sept. 1, 1969).

Nightglow emission was observed in a spectral band from 50 μ to 125 μ by using a rocket-borne liquid helium-cooled telescope. The observed zenith intensity as a function of altitude is consistent with the assumption that the emission is due to the $^3P_1 - {}^3P_2$ fine structure transition of O I at 63 μ. At 120 km, the zenith intensity is 1.7 megarayleighs or 5.5×10^{-2} erg sec^{-1} cm^{-2} (column), and the derived value for the atomic oxygen density is 4×10^{10} cm^{-3}. (auth)

44326 MAGNETOSPHERIC ELECTRIC FIELD MEASUREMENTS WITH BALLOONS. Mozer, F. S.; Serlin, R. (Univ. of California, Berkeley). J. Geophys. Res., 74: 4739-54(Sept. 1, 1969).

Two balloons have been flown from Fort Churchill, Canada, in August 1968 to measure horizontal and vertical electric fields. It is shown theoretically and experimentally that horizontal upper atmospheric electric fields are generally equal to one-second, several hundred kilometer averages of the horizontal ionospheric electric field. Analyses of thirty-five hours of data obtained during quiet and active periods yield the following conclusions. The average equatorial electric field strength was 0.6 mv/m during a quiet period and 1.0 mV/m during an active period. During magnetic bays, ground-based magnetometers principally measured Hall currents whose variations depended on conductivity changes as much or more than on electric field variations. For a period of about 30 minutes before the onset of a negative bay near local midnight, the ionospheric electric field pointed westward, indicating radially inward flow in the equatorial plane. This result is interpreted in terms of a model of the magnetospheric substorm in which bays are triggered deep within the magnetosphere by an instability associated with a radial plasma density gradient established by convective flow. The average electric field in the dayside ionosphere was about an order of magnitude smaller than that at night, suggesting that the dayside magnetosphere tended to corotate with the earth. Equipotential contours of the electric field in the equatorial plane are constructed based on this and other hypotheses. (auth)

44327 ESCAPING PHOTOELECTRONS AND DAYGLOW. Prasad, S. S. (Univ. of Florida, Gainesville). J. Geophys. Res., 74: 4772-6(Sept. 1, 1969).

Theoretical calculations were made for the photoelectron excitation rates of λ1304 and λ1356 radiations of O I. In the lower region, about 225 km and below, the excitation rates were practically the same whether the photoelectrons were localized or escaping. But the rates in the two cases differ rapidly as the altitude increases. At about 300 km the excitation rates with escaping photoelectrons are lower by a factor of about 1.5 to 2.0 relative to those with localized electrons. The theoretical results were compared with the corresponding observational data by scaling them to a common (experimental) value at about 175 km. It was found that the altitude dependence in the escaping photoelectron case was in better accord with the experiment. (auth)

44328 EVALUATION OF THE CRAND SOURCE FOR 10- TO 50-MeV TRAPPED PROTONS. Farley, T. A.; Tomassian, A. D. (Univ. of California, Los Angeles). J. Geophys. Res., 74: 4721-30(Sept. 1, 1969).

Proton intensities in two energy channels covering the range from 10 to 50 MeV, measured in November, 1965, with directional detectors on the OV1 2 (1965-78A) spacecraft, are reported. For $L < 1.4$ the intensities are greater than those reported by Freden, Blake, Paulikas (1965) for August 1964 by an amount that is just barely significant. Such differences do not appear at larger L values out to 2.1. The measured intensities are compared with the intensities predicted from cosmic-ray albedo neutron decay (CRAND) by Hess and Killeen (1966). The measured intensities are higher by factors of 100 and more in some regions. From this result, and from a review of the CRAND theory, it is concluded that CRAND is not the principal source of 10- to 50-MeV protons in the inner zone. (auth)

44329 CHARACTERISTICS OF THE DIURNALLY VARYING ELECTRON FLUX NEAR THE POLAR CAP. Israel, Martin H.; Vogt, Rochus E. (California Inst. of Tech., Pasadena). J. Geophys. Res., 74: 4714-20(Sept. 1, 1969).

The discussion is based on balloon observations made near Fort Churchill, Manitoba, in 1967, of both the electron flux vertically incident on the atmosphere and the electron splash albedo. An electron splash albedo flux below 100 MeV equal to the flux of electrons below 100 MeV incident on the atmosphere during daytime was measured. The observed diurnal variations of the flux of electrons with energies $\lesssim$100 MeV is consistent with geomagnetic cutoff variations calculated for models of the magnetosphere. A geomagnetic cutoff rigidity of $\lesssim$17 MV is deduced for the nighttime interval and between 70 and 110 MV for the daytime interval at an invariant latitude near 68° in 1967. (auth)

44330 EXPERIMENTAL VERIFICATION OF DRIFT-SHELL SPLITTING IN THE DISTORTED MAGNETOSPHERE. Pfitzer, K. A.; Lezniak, T. W.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 74: 4687-93(Sept. 1, 1969).

Data from an electron spectrometer on the synchronous-orbit satellite ATS 1 and data from an electron spectrometer and ion chamber on the elliptical-orbit satellite OGO 3 can be used experimentally to test drift-shell splitting in the nondipolar distorted magnetosphere as proposed by Roederer. Quiet-day pitch-angle distributions obtained by ATS 1 at 6.6 R_E qualitatively confirm the shell splitting by showing that near noon the pitch-angle distribution is nearly isotropic, whereas near midnight the pitch-angle distribution is peaked toward small angles (parallel to the field). By using the Mead model magnetic field for calculating the drift shells for electrons of pitch angle $\alpha = 65°$ and $\alpha = 90°$, as well as the measured pitch-angle distribution and measured radial gradient for electrons at local noon, the pitch-angle distribution can be calculated as a function of local time for the ATS 1 orbit. The agreement between calculated and measured fluxes is satisfactory not only in predicting the proper noon to midnight asymmetry (25 to 1 for 500- to 1000-keV electrons on February 15, 1967) but also in correctly predicting the pitch-angle distribution as a function of local time (when the pitch-angle distribution is isotropic at noon, it is nonisotropic with a 3 to 1 ratio between $\alpha = 65°$ and $\alpha = 90°$ at midnight). In one case (February 15, 1967), however an asymmetry is observed near local midnight with minimum count rate at 2200 LT, representing a departure from the symmetric Mead model. (auth)

44331 SATELLITE MEASUREMENTS OF AURORAL ULTRAVIOLET AND 3914-A RADIATION. Joki, E. G.; Evans, J. E. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 74: 4677-86(Sept. 1, 1969).

Satellite measurements of auroral ultraviolet and 3914-A radiation were made November 9 through 11, 1965, as part of a coordinated program of luminosity, particle precipitation, and ion and electron number density measurements. Auroral ultraviolet radiation in the 1230- to 1840-A region was observed on most satellite crossings of the auroral zones and was seen to occur with charged-particle precipitation. At those times when the auroral 3914-A intensity was sufficiently great to permit its observation despite the high moonlight background, good spatial correlation with the ultraviolet radiation was found. At the peaks of the auroral forms the intensities of the 3914-A radiation and of detected ultraviolet were comparable. (auth)

44332 IONOSPHERE ELECTRON CONTENT AT MIDLATITUDES NEAR THE MINIMUM OF THE SOLAR CYCLE. Merrill, R. G.; Lawrence, R. S. (Environmental Science Services Administration, Boulder, Colo). J. Geophys. Res., 74: 4661-6(Sept. 1, 1969).

Faraday rotation of signals at 40 and 41 MHz was observed from Explorer 22 for two years and a differential Faraday analysis was used to obtain the following results. Throughout a diurnal cycle, vertical columnar electron content was about one-fifth that during a diurnal cycle near solar maximum and varied by ratios of between 5 and 10 to 1. The average Chapman scale height varied from 66 to 70 km for Kp from 0 through 5, but jumped to 110 km for Kp equal to 6. The normalized gradient of content had, with some exceptions, median values varying between 1 and 4% per degree of latitude during the day, and varying between 7 and 10% with a great deal of spread at night. In general, the gradient was larger during 1965 than during 1966 and larger during the winter than during the summer; electron content almost always increased to the south. (auth)

44333 DEDUCTION OF IONOSPHERIC PARAMETERS FROM RETARDING POTENTIAL ANALYZERS. Patterson, T. N. L. (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 74: 4799-4801(Sept. 1, 1969).

A linearization of the analysis of data from retarding potential analyzers is described. A least-squares solution is used. (M.O.W.)

44334 SATELLITE OBSERVATIONS OF THE AVERAGE PROPERTIES OF AURORAL PARTICLE PRECIPITATIONS: LATITUDINAL VARIATIONS. Sharp, R. D.; Carr, D. L.; Johnson, R. G. (Lockheed Palo Alto Research Lab., Calif.). J. Geophys. Res., 74: 4618-30(Sept. 1, 1969).

The results of a statistical study of the auroral particle data from satellite 1963-42A have shown some interesting systematics in the averaged properties of the low-energy particles. When data from 216 traversals of the auroral zones were averaged over 1° intervals of invariant latitude, a statistically significant "soft" electron zone was found at high latitudes at local times near midnight and noon. Both the averaged pitch-angle distributions and energy spectral distributions of the auroral electrons were found to vary systematically with latitude. The averaged energy distributions in the "hard" zone hardened dramatically with decreasing latitude on the dayside, in reasonably good agreement with expectations assuming they were precipitated from a quasi-trapped parent population that was drifting in L under conservation of the first two adiabatic invariants. This process could be a source for energetic outer-belt electrons. On the nightside, the dependence on latitude was less pronounced, but there was evidence for a maximum in the spectral hardness near the center of the zone. The averaged angular distributions were almost isotropic near the center of the zone and became highly anisotropic in the wings, with the maximum flux at high pitch angles. The auroral proton precipitation zone consisted of a single peak that exhibited a diurnal variation of 8½°. (auth)

44335 INITIAL OBSERVATIONS OF VLF ELECTRIC AND MAGNETIC FIELDS WITH THE INJUN 5 SATELLITE. Gurnett, Donald A.; Pfeiffer, G. William; Anderson, Roger R.; Mosier, Stephen R.; Cauffman, David P. (Univ. of Iowa, Iowa City). J. Geophys. Res., 74: 4631-48(Sept. 1, 1969).

The Injun 5 satellite, launched into a low-altitude (677 to 2528 km) polar orbit on August 8, 1968, carried a very-low-frequency (vlf) electric and magnetic fields experiment covering the frequency range from dc to 105 kHz for electric fields and from 30 Hz to 10 kHz for magnetic fields. This paper describes the vlf experiment and presents initial results of immediate interest. Broadband (30 Hz to 10 kHz) electric field intensities are found to be remarkably small, typically less than 100 μv/m and seldom greater than 1 mV/m. Most of the common types of vlf electromagnetic noise, electron and proton whistlers, chorus, elf hiss, vlf hiss, and periodic emissions, were observed simultaneously with both the electric and magnetic antennas, thus providing an excellent check on the operation of the electric antenna. Phase measurements between the electric and magnetic fields were used to determine the direction of propagation, up or down the geomagnetic field. New phenomena observed include (1) spin modulation of lower hybrid resonance noise, (2) multiple frequency noise bands possibly related to lower hybrid resonance noise, (3) a narrow bandwidth electric field enhancement near the two-ion cutoff frequency, and (4) noise bands associated with harmonics of the proton gyrofrequency. (auth)

44336 IONOSPHERIC PROPAGATION PREDICTIONS. Wood, H. Charles. Electron. World, 81: 27-9; 67(Apr. 1969).

The effect of solar activity and other factors on propagation of electromagnetic energy through the ionosphere is reviewed. A linear relation between the F2 ionosphere layer and the sunspot number has been established, and observations made during the succeeding 11-yr solar cycles continue to correlate well with the sunspot number. Generally, as the sunspot number increases during the 11-yr solar cycle, the F2 layer increases in density and altitude, permitting the higher frequencies to be propagated. Three other sunspot variations must be taken into account when predicting solar activity: (1) solar rotation about 27 days; this causes the longer-lived sunspots to reappear several times on the Earth side of the Sun's surface; (2) seasonal changes brought about by the difference in solar radiation reaching the two hemispheres during the winter and summer months; (3) detectable waxing and waning of sunspot numbers over long periods of time (100 yr or more). Occasionally, during times of maximum 11-yr cycles, tremendous bursts of solar energy eject charged particles into space around the Sun, and often cause the F2 layer to temporarily disappear, bringing about a complete radio circuit breakdown above about 4 MHz. How ionospheric soundings are made is discussed. (BBB)

44337 A STATISTICAL STUDY OF HORIZONTAL DRIFTS AND ANISOTROPY OF IRREGULARITIES IN THE F2 REGION. Rao, Ganti L. (Bendix Aerospace Systems Div., Ann Arbor, Mich.); Ramachandra, B. J. Atmos. Sci., 26: 580-6(May 1969).

Behavior of horizontal drifts and anisotropy of irregularities in the F2 region of the ionosphere was studied with the original pulse fading drift records obtained from Waltair, Yamagawa, DeBilt, and Halley Bay during the IGY. A full correlation analysis was used in deducing the drift and anisotropy parameters. Harmonic analysis was adopted to isolate the periodic components of the drift velocities. It was found that the axial ratio of the spatial correlation ellipse decreased systematically from the equator to high latitudes; however, the polar region values are high and nearer to the equatorial values. The tilt angle or the orientation of the semi-major axis of the spatial correlation ellipse rotates systematically from north–south to east–west with increase of latitude at the equator. Thus the orientation of spatial correlation ellipse tends to align more along the Earth's magnetic field at the equatorial latitudes. The length of the semi-major axis of the spatial correlation ellipse also shows a systematic decrease in average value with increase in latitude except in the polar regions where the values are found to be higher. The diurnal variation of anisotropy parameters of the spatial correlation ellipse is irregular and shows no regular variation with the latitude. The rotation of the drift vectors with time is generally clockwise in the Northern Hemisphere and counterclockwise in the Southern. (BBB)

44338 HYDROMAGNETIC WAVES IN THE IONOSPHERE: PROPAGATION THROUGH INHOMOGENEOUS AND CURRENT CARRYING REGIONS. Abbas, Muhammad. Kingston, R. I., Univ. of Rhode Island, 1967. 139p.

Thesis.

Hydromagnetic waves generated in various regions of the magnetosphere and propagated to the Earth in the extremely low-frequency spectrum are analyzed. Two different aspects of the problem are investigated, namely, propagation through inhomogeneous regions of the ionosphere and propagation and excitation of waves in current-carrying regions of the ionosphere and the magnetosphere. (TSS) (Diss. Abstr.)

44339 GEOMAGNETIC RAPID VARIATIONS AND IONOSPHERIC PERTURBATIONS. Boyd, Gary McIntyre. Vancouver, B. C., Univ. of British Columbia, 1968.

Thesis.

The object of this study was to determine the kinds and frequency of occurrence of direct associations between rapid variations in the geomagnetic field and ionospheric perturbations at subauroral-zone latitudes. Simultaneous observations of the magnetic field and of several characteristics of ionospherically propagated radio waves were made near Vancouver, British Columbia (54°N geomagnetic latitude) during the years of low solar activity 1962–1967. (TSS) (Diss. Abstr.)

44340 AN EXPERIMENTAL STUDY OF ELECTRON FLUXES FROM 50 keV TO 4 MeV IN THE INNER RADIATION BELT. Pfitzer, Karl Adalbert. Minneapolis, Univ. of Minnesota, 1968. 167p.

Thesis.

A five-channel magnetic electron spectrometer capable of accurately measuring the electron spectrum from 50 keV to 4 MeV is described. Two spectrometers cross calibrated in space, and shown to agree to within 10%, observe the continuing decay of the electrons injected into the inner zone by the nuclear explosion, Starfish, on July 9, 1962. The spectrometers observe a factor of ten decrease in the electron flux over a period of two years from September 1964 to August 1966 in the inner zone below L = 1.8 for electrons of E > 290 keV. This decrease is attributed to the decaying Starfish electrons by comparing the decrease and flux levels to experiments that have measured the Starfish decay since shortly after the detonation. The 50 to 120-keV electrons, however, are observed to increase slightly during this two year period and the 120- to 290-keV electrons are observed to have a two year decay rate intermediate between the 50- to 120-keV electrons and the 290- to 690-keV electrons. The diffusion-like injection of electrons of energy up to 690 keV deep into the inner zone to L = 1.3, creating a new and stable inner zone of natural origin, was observed following the magnetic storm associated with the September 2, 1966 solar flare. No increase in this region below L = 2.0 was observed for electrons of energy greater than 690 keV. Within one day of the onset of the event a wave of electrons was observed to penetrate to L = 2.0; following this initial wave there is a slow diffusion inward, such that the maximum increase at L = 1.4 (e.g., a factor of 3 increase for 290- to 690-keV electrons) is reached 30 days after the onset of the event. The increase immediately after the arrival of the wave for L > 2.0 is very large (e.g., more than an order of magnitude for 290- to 690-keV electrons at L = 2.2); this large increase, however, begins an immediate rapid exponential decay (τ = 13 days at L = 2.2 for 290- to 690-keV electrons) such that by mid-October the fluxes decayed to prestorm levels. For L < 2.0 on the other hand, no rapid decay is observed and the "new" zone resumes the slow decay (τ = 300 to 400 days) observed during the two years prior to the September 2, 1966 event. Because of the very slow decay following the injection, the electrons injected by the September 2, 1966 event will decay to the prestorm levels for L < 2.0 in about one year. Therefore, only one or two events of this magnitude would suffice to supply the inner-zone electrons (50 < E < 690 keV) below L = 2.0. The equatorial pitch-angle distributions for all L values in the inner zone during the entire two-year period including the injection event were found to be flat near $\alpha_0 = 90°$ and drop off rapidly near the loss cone. (Diss. Abstr.)

44341 ELECTRIC ACCELERATION OF AURORAL PARTICLES. Chamberlain, Joseph W. (Kitt Peak National Observatory, Tucson, Ariz.). Rev. Geophys., 7: 461-82(Aug. 1969).

Measurements of the distribution of auroral particles with energy and pitch angle have not given much of a clue to the precipitating mechanism, except to indicate that it occurs locally, in the magnetosphere. The available data, including observations of periodicities in auroral bombardment, hint that at least two different mechanisms are operative. With the aid of a simplified model for an accelerating electric field, the kind of dependences on angle and energy to be expected are illustrated. Quantitative discussion is restricted to cases where the electric potential is small compared with the energy dispersion of trapped particles, and the results are thus probably more applicable to instability mechanisms than to the electrostatic precipitation treated by Taylor and Hones. Simultaneous measurements of the spectrum at different pitch angles above the atmosphere could be combined to test any given model of electric acceleration. In spite of the wealth of measurements, adequate data do not yet seem to be available. (auth)

44342 IONIZATION RATES DUE TO THE ATTENUATION OF 1 TO 100 A NONFLARE SOLAR X RAYS IN THE TERRESTRIAL ATMOSPHERE. Swider, W. Jr. (Air Force Cambridge Research Labs., Bedford, Mass.). Rev. Geophys., 7: 573-94(Aug. 1969).

Solar fluxes and absorption cross sections are reviewed for 1- to 100-Å x rays. Review of the cross sections is extended to 300 Å to more completely validate the cross sections selected at shorter wavelengths. Convenient lists of the solar flux and appropriate cross sections are provided, and simple accurate formulas are given for them. Numerical rates for q, the total ion-pair production rate, are tabulated for three nonflare solar conditions at various altitudes and solar zenith angles. Production rates due to other ionization sources important at these altitudes and angles are also tabulated. It is shown that q is distributed as 0.62 : 0.17 : 0.14 : 0.07 for $q(N_2^+) : q(O_2^+) : q(N^+) : q(O^+)$ for 1- to 100-Å x rays absorbed in normal composition air. The atomic ions result from dissociative ionization, mainly by photoelectrons. About half of these atomic ions are converted immediately into NO^+ ions at the altitudes where 1- to 100-Å x rays are absorbed, the E and D regions. Preliminary evidence concerning excited ions directly formed during the atmospheric attenuation of 1- to 100-Å x rays suggests that the ions are ineffective as regards the ultimate ionic composition of the lower ionosphere as compared, for example, with $NO^+ + e \rightarrow N + O$. This major neutralization process allows atomic nitrogen to be formed in the ^2D state. No survey of excited neutrals formed by the x-ray photoelectrons was undertaken. (auth)

44343 AURORAL ABSORPTION OF HF RADIO WAVES IN THE IONOSPHERE: A REVIEW OF RESULTS FROM THE FIRST DECADE OF RIOMETRY. Hargreaves, J. K. (Environmental Science Services Administration Research Labs., Boulder, Colo.). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1348-73(Aug. 1969).

In the decade since the International Geophysical Year, information about the ionospheric absorption of radio waves during periods of auroral and magnetic disturbance has been greatly increased by the use of the riometer technique. Such studies are important for their geophysical implications as well as in direct applications to radio propagation. The purpose of this paper is to summarize the state of knowledge of auroral radio absorption at about the end of 1968, and at the same time to give the major references through which the reader may be enabled to study any particular questions in greater depth. (auth)

44344 IONOSPHERIC ELECTRON TEMPERATURE CALCULATIONS INCLUDING PROTONOSPHERIC AND CONJUGATE EFFECTS. Nagy, A. F.; Fontheim, E. G.; Stolarski, R. S.; Beutler, A. E. (Univ. of Michigan, Ann Arbor). J. Geophys. Res., 74: 4667-76(Sept. 1, 1969).

Electron temperature profiles are calculated for midday equinoctial conditions by taking into account photoelectrons produced in both hemispheres as well as the energy conducted down along the magnetic field lines from the protonosphere. Detailed calculations of the energy loss by the photoelectrons and secondary electrons, via both inelastic collisions with neutrals and elastic collisions with ambient electrons, are performed. Above 200 km, the nonlocal energy degradation effects are taken into account. The energy lost by the photoelectrons and secondary electrons to the protonospheric ambient electrons is used to calculate the heat conducted down from the protonosphere, which is of the order of 8×10^9 eV cm^{-2} sec^{-1}. The electron temperature profiles are obtained by solving numerically the heat equation; the results are compared with corresponding temperatures measured by Evans at Millstone Hill. (auth)

44345 DIURNAL VARIATIONS IN THE THERMOSPHERE FROM A SERIES OF MARSHALL–UNIVERSITY-OF-MICHIGAN PROBES. Weidner, Don K.; Swenson, Gary R. (Marshall Space Flight Center, Huntsville, Ala.). J. Geophys. Res., 74: 4755-64 (Sept. 1, 1969).

To investigate the diurnal variation in the concentration and temperature of molecular nitrogen, six Marshall–University-of-Michigan probes were launched from Cape Kennedy, Florida, on January 24, 1967. Omegatron mass spectrometers measured the N_2 concentration from 150 to 320 km, and temperature was derived from the N_2 scale height. Under the assumption of diffusive equilibrium, O_2 and O concentration profiles were calculated so that the total mass of the N_2, O_2, and O would be in agreement with densities determined for satellite drag data above 300 km. The calculated concentration profiles of N_2 and O_2 are in excellent agreement with other direct observations but are in poor agreement with theoretical model atmospheres that are based on satellite-drag-determined densities. Diurnal variations in the constituent concentrations, temperature, and mass density are found to be completely reasonable with maximum values near 1400 hours and minimum values near 0400 hours. For rocket-borne mass spectrometer measurements, the wall loss coefficient is indicated to be near 1 for atomic oxygen. The well-known controversial factor-of-two difference between density determined from satellite-drag and that obtained from mass spectrometers can be resolved when reasonable physical assumptions are made. (auth)

44346 NEW THEORY OF MID-LATITUDE SPORADIC E. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 223: 794-7(Aug. 23, 1969).

Unified explanations are derived for the main statistical and structural characteristics of sporadic E. (auth) (UK)

44347 THE HYDROGEN LYMAN-ALPHA AIRGLOW. Meier, Robert R. (Naval Research Lab., Washington, D. C.). Astronaut. Aeronaut., 7: 68-75(May 1969).

Several models that might explain the far-uv glow about the Earth, the Lyman-α resonance transition of atomic H at 1216 Å, are considered on the basis of rocket and satellite data. One model suggests that most of the hydrogen is contained within sev-

eral Earth radii (the geocorona model). The hydrogen would be present in sufficient quantity to be optically thick to Lyman-α radiation, and the solar photons then scattered several times before they escape from the atmosphere or are absorbed. Another model would place most of the telluric hydrogen at heights greater than ~5 R_E, and the distribution would have a long cylindrical tail (geocoma) in the antisolar direction. A third model suggests that the Lyman-α excitation at night comes from bombardment of hydrogen by energetic particles, perhaps precipitating from the radiation belts. To discriminate between various theoretical models, the characteristics of the Lyman-α airglow are examined in detail. Profiles of the Lyman-α emission rate have demonstrated that most of the Lyman-α airglow comes from multiple scattering of solar radiation in a geocorona contained within some 3 to 5 R_E. This can be seen by considering the general features of the airglow as measured by rockets and satellite experiments. Rocket experiments show that the overhead intensity rises rapidly above 90 km and reaches a plateau near 120 km during the day and near 200 km at night. The geocoma and particle-excitation models encounter severe difficulties in explaining these observations. The nighttime Lyman-α intensity is much too high to be explained by either of these theories. Hot interplanetary hydrogen may scatter solar Lyman-α photons, and the broad emission line could be accounted for by Doppler broadening by fast-moving atoms. Enhancements in the galactic plane may be present in this model if protons in the solar wind are concentrated in the plane of the Milky Way by the galactic magnetic field. With the availability of complete satellite mappings of Lyman-α, from low altitude (around 600 km) and from several R_E, it should be possible to decide to what extent the theoretical models describe the hydrogen distribution. (BBB)

Low-Temperature Physics

Refer also to abstracts 43534, 43556, and 43638.

44348 (AD-687713) TWO KINDS OF BOSONS AND BOSE CONDENSATES. Kohn, W.; Sherrington, D. (California Univ., La Jolla, San Diego. Dept. of Physics). Apr. 29, 1969. Contract Nonr-2216(11). 45p. (TR-57). CFSTI.

Ordinary material systems are dealt with, whose elementary constituents are fermions. It is pointed out that in such systems there can occur two kinds of bosons. Type-I bosons are bound complexes of an even number of fermions (such as He-4); and type-II bosons are elementary excitations which are bound complexes of fermions and their holes (such as excitons). When the first type condenses, a superfluid state results with so-called off-diagonal long-range order; while when the second type condenses there is no superfluidity but a change in spatial order. Thus, both kinds of long-range order are related to Bose condensation. (auth) (USGRDR)

44349 COUPLING BETWEEN FERRIMAGNETIC INSULATORS THROUGH A SUPERCONDUCTING LAYER. Hauser, J. J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 23: 374-7(Aug. 18, 1969).

In agreement with a recent theoretical prediction of de Gennes, the transition temperature of In (or another superconductor) films sandwiched between two magnetic films depends on the relative orientation of the magnetization of these ferrites. The highest transition temperature (nearly the T_c of bulk In, 3.4°K) is obtained when the two ferrites are deposited in antiparallel magnetic fields, while the lowest (≈1°K) occurs when the ferrites are deposited in parallel magnetic fields. The depression of the transition temperature of an indium film sputtered or evaporated between two magnetic films magnetized in parallel fields is inversely proportional to the thickness of the In film. (auth)

44350 SUPERCONDUCTING TRANSITION TEMPERATURE IN THE PSEUDO-BINARIES V_3Al—V_3X. Asada, Tsunesaburo; Horiuchi, Takefumi; Uchida, Mitsuo (Kobe Steel, Japan). Jap. J. Appl. Phys., 8: 958(July 1969).

An attempt is made to predict the superconducting transition temperature T_c of V_3Al with β-W structure by studying the dependence of T_c on the lattice parameters a in the pseudo-binary systems V_3Al-V_3X, where X = Si, Ga, Ge, Sn, and Sb. All the V_3X compounds have β-W structures. The results seem to indicate that V_3Al would not be a high-temperature superconducting material contrary to Matthias' [Science 156: 645(1967)] prediction. (M.H.R.)

44351 EFFECT OF FLUCTUATIONS IN THE SUPERCONDUCTING ORDER PARAMETER ON THE TUNNELING DENSITY OF STATES. Cohen, Roger W.; Abeles, B.; Fuselier, C. R. (RCA Labs., Princeton, N. J.). Phys. Rev. Lett., 23: 377-80 (Aug. 18, 1969).

Fluctuations in the superconducting order parameter above the transition temperature result in structure in the tunneling density of states. From the shape of this structure a value is derived for the decay rate of the fluctuations. (auth)

44352 ARGONNE NATIONAL LABORATORY NOW OPERATING KINGSIZED SUPERCONDUCTING MAGNET. Purcell, John R. (Argonne National Lab., Ill.). Cryog. Ind. Gases, 4: No. 6, 64-6(June 1969).

Development of the 18-kG superconducting magnet at Argonne National Laboratory is described. This magnet operates at about one-tenth the cost of an equivalent conventional magnet. The design of and uses for this magnet are summarized. (M.H.R.)

44353 USE OF HELIUM AT PRESSURES ABOVE THE CRITICAL FOR COOLING SUPERCONDUCTING SYSTEMS UNDER CONDITIONS OF COSMIC FLIGHT. Anashkin, O. P.; Belitskii, B. M.; Brodskii, V. B.; Kurnosova, L. V.; Mikhailov, N. N.; Razorenov, L. A.; Sidyakina, T. M.; Fradkin, M. I. (Physics Inst., Moscow). Cryogenics, 9: 210-12(June 1969).

Under conditions of weightlessness, when there is no hydrostatic pressure in the liquid, special precautions have to be taken to separate the liquid and vapor phases, since it is possible for the liquid helium to pass out of the cryostat through the neck. The best solution for keeping the helium in the cryostat seemed to be to raise the pressure slightly above critical. A cryostat was constructed to test experimentally the possibility of keeping helium at pressures above critical under conditions of weightlessness and of operating superconducting magnets under these conditions. The experiment was carried out in the artificial earth satellite "Cosmos-14ϕ." The results are given. (UK)

44354 SUPERFLUID VORTEX TRAPPING NEUTRAL IMPURITIES. Ohmi, Tetsuo; Usui, Tunemaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1401-15(June 1969).

Structure and energy of a superfluid vortex line and a neutral impurity (^{3}He) trapped by it are investigated in the Hartree-Fock approximation. In dilute gas, the shape of the impurity is prolate along the vortex line, while in dense gas it becomes more spherical. In liquid helium the ratio of the axes is estimated at $\sqrt{0.842}$ and the binding energy at 3.5°K. A rough estimate of the saturation density is given. It is pointed out that at this density the tension has decreased to 60% of that in pure ^{4}He. (auth)

44355 PHASE SEPARATION IN ROTATING HELIUM. Ohmi, Tetsuo (Nagoya Univ., Japan); Tsuneto, Toshihiko; Usui, Tunemaru. Progr. Theor. Phys. (Kyoto), 41: 1395-1400(June 1969).

It is pointed out that a uniform superfluid solution of ^{3}He-^{4}He at low temperature will show the phase separation when rotated. The normal ^{3}He rich fluid occupies the central region of a vortex line, the radius of which is determined as a function of the ^{3}He concentrations in the absence of rotation. The dispersion relation is derived for waves associated with the oscillations of the phase boundary. (auth)

44356 PHENOMENOLOGICAL THEORY OF SUPERFLUIDITY NEAR THE λ POINT. Usui, Tunemaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 41: 1603-5(June 1969).

A theory of superfluid dynamics that is essentially a revision of Pitaevskii's theory is proposed, which describes the singular behavior of the transport coefficient correctly according to recent experimental results. (M.H.R.)

44357 EFFECT OF THERMODYNAMIC FLUCTUATION OF THE SUPERCONDUCTIVITY ORDER PARAMETER ON THE TUNNELING CURRENT. Tsuzuki, Toshio (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 41: 1600-1(June 1969).

The effect of thermodynamic fluctuation of the superconducting order parameter on the tunneling current through a normal metal-normal metal junction is studied. Temperature of the system is assumed such that it is just above the transition temperature of the metal on the right-hand side but sufficiently above that of the metal on the left-hand side. Therefore, the fluctuation effects in the left-hand metal can be neglected completely. Thermal techniques of calculation are used. (M.H.R.)

44358 SUPERCONDUCTIVITY IN THE DILUTE LEAD REGION OF Cu-BASED Cu-Si-Pb ALLOYS. Rapp, Oesten (Royal Inst. of Tech., Stockholm). Ark. Fys., 39: 241-56(1969).

The resistance as a function of temperature was measured for a set of alloys of Cu-Si-Pb in a highly cold-worked state in the lead concentration range below 0.60 at.%. It was observed that the critical temperature decreases with decreasing lead concentration. The transition is gradually more incomplete when the lead concentration decreases, but superconducting effects are apparent even for 0.05 at.% Pb alloys. The effect of cold work was investigated on 0.28 at.% Pb alloys within a large cold-working range. With increasing cold work the resistive width of the resistance temperature transitions increases. For moderate cold work there

is only a small or no effect on the critical temperature. Above a certain degree of cold work, however, the critical temperature decreases with increasing cold work. Resistive measurements in longitudinal magnetic fields for these latter specimens show a decrease of the critical field with increasing cold work close to the critical temperature and an increase of the critical field with increasing cold work at lower temperatures. Some indications of the preserved integrity of the two phases are given by the phase diagram and microphotograms and by the observation that, under this assumption, the critical field is inversely proportional to the diameter of the lead precipitates over a certain range of cold work. Reasons are given why internal stresses are less likely to explain the results. Instead, it is noticed that a proximity effect could possibly explain all effects observed on T_c. (Sweden)

44359 SPIN FLUCTUATIONS ASSOCIATED WITH THE FORMATION OF LOCALIZED MAGNETIC MOMENTS IN SUPERCONDUCTORS. Bennemann, K. H. (Univ. of Rochester, New York). Phys. Rev., 183: 492-6(July 10, 1969).

A new theory of superconductors containing transition metal impurities is presented, explaining the observed anomalous magnetic behavior of the impurities with quenched or nearly quenched magnetic moment resulting from the localized spin fluctuations associated with the formation of localized magnetic moments. From this theory, the superconducting transition temperatures of AlMn, AlCr, and VFe are calculated. The puzzling "slowing down" of the decrease in T_c observed for higher concentrations of transition-metal impurities is shown to arise partly from the temperature dependence of the electron scattering by the localized spin fluctuations and also partly from exchange and Coulomb coupling among its transition-metal impurities, which damp the formation of the localized magnetic moments and the spin fluctuations. (auth)

44360 INELASTIC SCATTERING OF LIGHT BY CHARGE DENSITY FLUCTUATIONS IN A SUPERCONDUCTOR. Tong, S. Y.; Maradudin, A. A. (Univ. of California, Irvine). Mater. Res. Bull., 4: 563-72(Aug. 1969).

The dependence of the efficiency for Raman scattering of light from single-particle excitations in a superconductor at absolute zero temperature on the frequency shift and on the scattering vector was calculated. (auth)

44361 FLUXOID PINNING IN NONIDEAL TYPE-II SUPERCONDUCTORS. I. FORCE BETWEEN A FLUXOID AND A LATTICE DEFECT. Miyahara, Kuniyuki; Irie, Fujio; Yamafuji, Kaoru (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap., 27: 290-300(Aug. 1969).

A general expression of the interaction energy between fluxoids and lattice defects is obtained by perturbational calculations of the generalized Ginzburg–Landau equations, which are derived by minimizing the free energy of the mixed state including elastic terms. The present expression is the same as Labusch's obtained only for a special type of lattice defects with a pure shear, but is shown to be applicable to any type of defects. The interaction force between a fluxoid and a lattice defect is derived for some typical types of defects by the use of the present expression of interaction energy, and the results of previous authors are shown to be unsatisfactory, even qualitatively. The present results give the first step for the derivation of a general expression of the so-called "pinning force," which is the final purpose of this series. (auth)

44362 SUPERCONDUCTING, THERMAL, AND MAGNETIC SUSCEPTIBILITY BEHAVIOR OF SOME INTERMETALLIC COMPOUNDS WITH THE FLUORITE STRUCTURE. Wernick, J. H.; Menth, A.; Geballe, T. H.; Hull, G.; Maita, J. P. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem. Solids, 30: 1949-56(Aug. 1969).

$AuGa_2$ becomes superconducting at 1.12°K. The superconducting critical temperature rises rapidly with small additions of Pd. For the composition corresponding to $Au_{0.95}Pd_{0.05}Ga_2$, T_c = 1.79°K, and then remains essentially constant with further increase in Pd content. The electronic contribution to the heat capacity, γ, increases in a similar manner. At $Au_{0.95}Pd_{0.05}Ga_2$ the change in γ amounts to 18.4% per at.% Pd. All of the $Au_{1-x}Pd_xGa_2$ materials are diamagnetic but the diamagnetism decreases with increasing Pd content. The behavior of the susceptibility per gram atom, χ_A, at 0°K as a function of Pd content parallels the behavior of T_c, γ, and the ^{71}Ga Knight shift in these alloys $AuAl_2$ and $AuIn_2$ become superconducting below 0.1°K and both show temperature independent diamagnetism, in contrast to the behavior of $AuGa_2$. (auth) (UK)

44363 SUPERCONDUCTING LEADS FOR CRYOGENIC APPLICATIONS. Anderson, A. C. (Univ. of Illinois, Urbana); Bloom, D. W. Rev. Sci. Instrum., 40: 1243-4(Sept. 1969).

The results of a series of measurements on manganin wires coated with various superconductors are reported. Those tested were Pb, $Pb_{0.40}Sn_{0.60}$, $Pb_{0.50}Sn_{0.50}$, and In_xSn_y of various compositions. The InSn coatings did not superconduct even when annealed. The most reliable material was found to be a stranded cable of three manganin wires coated with $Pb_{0.50}Sn_{0.50}$ alloy. (M.H.R.)

44364 FIZIKA NIZKIKH TEMPERATUR. III. (Low-Temperature Physics. III.). Tsakadze, Dzh. S. (ed.). Tbilisi, USSR, Izdatel'stvo Metsniereba, 1968. 92p.

Topics discussed in the 5 articles are: Cu phase transitions in rotating liquid helium; shift of the λ point in the liquid rotating ring gap; phase transitions of He II → He I and He I → He II; slip and decay of vortices in rotational He II; and slow neutron scattering by vanadium at low temperatures, with and without magnetic fields. (R.V.J.)

44365 NONLINEAR EFFECTS IN A SUPERCONDUCTOR IN AN ALTERNATING FIELD. Fedorov, M. A. (Inst. of Theoretical Physics, Moscow). JEPT Lett. (USSR) (Engl. Transl.), 9: 394-6(June 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu, 9: 639-42(June 5, 1969).

When the temperature of a superconductor approaches the critical value, nonlinear effects appear, even in a weak alternating field. Calculations are presented of the generation of third harmonics ($3\omega_0$) and combination frequencies, and of the surface impedance of a superconductor in a strong alternating electromagnetic field. (D.L.C.)

44366 INTERACTION FORCE BETWEEN A VORTEX LINE AND A PARALLEL DISLOCATION. Kammerer, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi, 34: 81-94(July 1, 1969). (In German).

Starting from formulas of a previous paper determining the internal stress field of an isolated vortex line due to the volume effect and the stress field due to the ΔC effect of a vortex line in the neighborhood of a parallel dislocation, the interaction force between a vortex line and a parallel dislocation is calculated in first-order perturbation theory (corresponding to first powers in the changes of specific volume and elastic constants throughout the superconducting phase). The numerical results communicated for $\varkappa = 1/\sqrt{2}$, 1, 2, and 5 apply to an arbitrary choice of the twelve interaction parameters of an elastically isotropic material and to an arbitrary character of the dislocation. (auth)

44367 EFFECTS OF PARAMAGNETIC IMPURITIES ON SUPERCONDUCTING PROPERTIES IN THE $La_{3-x}Gd_xAl$ SYSTEM. Kuwasawa, Yoshinori; Sekizawa, Kazuko; Usui, Nobumitsu; Yasukochi, Ko (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 27: 590-600(Sept. 1969).

Effects of the magnetic impurity on superconducting properties were investigated on the $La_{3-x}Gd_xAl$ system. The superconducting transition temperature T_c, the upper critical field H_{c2} and the magnetic susceptibility in the normal state were measured for various concentrations of gadolinium. A remarkable departure of the T_c versus impurity concentration curve from the Abrikosov–Gor'kov curve was found in the region of high impurity concentrations (>0.4 at. % Gd). Magnetic susceptibility versus temperature curves of compounds with Gd concentrations large enough to suppress the superconductivity showed no peak above 4.2°K. The H_{c2} versus temperature curve of the compound with 0.3 at. % Gd crossed the curve of La_3Al. The upper critical field at 0°K, $H_{c2}(0)$, had a maximum at a certain Gd concentration near La_3Al. This fact is qualitatively explained by the theory of Fulde–Maki. (auth)

44368 MAGNETIZATION, FLUX FLOW RESISTANCE, AND HALL EFFECT IN SUPERCONDUCTING VANADIUM. Usui, Nobumitsu; Ogasawara, Takeshi; Yasukochi, Ko; Tomoda, Shigenobu (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 27: 574-90(Sept. 1969).

The magnetization, flux flow resistivity, and Hall voltage were measured for three vanadium specimens with different purities. The parameters pertinent to the magnetic properties of type-II superconductors near the upper critical field H_{c2}—the Ginzburg–Landau–Maki parameters k_1 and k_2 and the Helfand–Werthamer parameters h* and (dh/dt)—were obtained from the data. It was found that the values of k_1, k_2 and h* at 0°K increased with increasing purity and the magnitude of the increase of them was larger than the value expected from the microscopic theory. This discrepancy between experiment and theory seems to correspond to the effect of the nonspherical Fermi surface suggested by Hohenberg and Werthamer. Resistivity measurements showed that with increasing purity, the behavior of the slope of the flow resistivity near H_{c2} changed from that of the dirty material predicted by Caroli–Maki to that of the intermediate material. This result is different from the Kim's empirical relation. The Hall

angle in the mixed state is found to be strongly dependent on the electron mean free path. (auth)

44369 PRESSURE EFFECT ON THE MAGNETIC PROPERTIES OF SUPERCONDUCTING Pb–Tl AND Pb–In ALLOYS. Takata, Mitsuhiro (Osaka Univ.). J. Phys. Soc. Jap., 27: 615-21(Sept. 1969).

The pressure dependence of the Ginzburg–Landau parameter, k, in some Type-II superconductors was measured. Pressures up to 3,000 atm were applied using a high pressure bomb with kerosene–oil mixture as the transmitting medium. For Pb–3.5 at. % Tl and Pb–3.5 at. % In, dln k/dp is -12.6 ± 1.8 and $-12.1 \pm 4.5 \times 10^{-6}$ atm^{-1}, respectively. The Gor'kov formula, which connects k with the electronic specific heat coefficient, γ, and the residual resistivity, ρ, is well satisfied with the observed values of dln k/dp, dln γ/dp and dln ρ/dp. The difference in the pressure effect on the effective electron–electron interaction parameter between the above two alloys was found to be greater than that on γ, which is proportional to the density of states at the Fermi level. The pressure dependence of the upper-critical field is in good agreement with the data calculated from the bulk modulus jump. (auth)

44370 SUPERCONDUCTIVITY IN NIOBIUM CONTAINING FERROMAGNETIC GADOLINIUM OR PARAMAGNETIC YTTRIUM DISPERSIONS. Koch, C. C.; Love, G. R. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 40: 3582-7(Aug. 1969).

Gadolinium and yttrium dispersions were prepared in pure niobium by solidification from the melt; the size, shape, and distribution of the particles were determined metallographically. The superconducting critical temperature and critical field of niobium were unaltered by the presence of the dispersions indicating that neither gadolinium nor yttrium have measurable solubility in solid niobium. Both gadolinium and yttrium dispersions produced large hysteresis in magnetization and large critical current densities. The degree of magnetic hysteresis produced in niobium by these dispersions has only been exceeded in niobium by fast-neutron irradiation. Ferromagnetic gadolinium and weakly paramagnetic yttrium appear equally effective as flux pins. It is suggested that the nature of the particle superconducting matrix interface is more important for flux pinning than the bulk magnetic properties of the dispersed phases. (auth)

44371 SOME THERMODYNAMIC RELATIONS FOR SUPERCONDUCTING ELLIPSOIDS. Zooler, Paul; Dillinger, J. R. (Univ. of Wisconsin, Madison). Amer. J. Phys., 37: 519-29 (May 1969).

Under the assumption that no latent heat is associated with the phase changes that occur when a superconducting ellipsoid of type I material (or type II material) enters or leaves the intermediate (or mixed) state in a constant uniform applied field, finite jumps are expected in the specific heat at constant applied field, when these phase changes occur. The jumps are related to the magnetization curves at constant temperature. (auth)

44372 ON THE EXISTENCE OF THERMOELECTRIC AND THERMOMAGNETIC EFFECTS IN SUPERCONDUCTORS. Balazs, N. L. (Cambridge Univ., Eng.). Physica, 41: 393-6(Mar. 7, 1969).

It is shown that there exists no generalization of London's equation that is linear in grad T, invariant under spatial reflections, and would alter the current distribution. There are, however, two generalizations which are bilinear in grad T; they suggest the existence of a thermomagnetic effect. (auth)

44373 LOW TEMPERATURE SPECIFIC HEAT OF ANNEALED HIGH-PURITY NIOBIUM IN MAGNETIC FIELDS. Ferreira da Silva, J.; Burgemeister, E. A.; Dokoupil, Z. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 41: 409-39(Mar. 7, 1969).

The specific heat of annealed niobium wires with a resistance ratio of 145 was measured at constant magnetic fields in the temperature range from 1 to 10°K. Analyzing accurately the normal state data below 3°K, θ was found to be temperature dependent. The specific heat in the mixed state for $H > H_{c1}(0)$ contains a term, which is linear in T and field-dependent. The transition at $H_{c1}(T)$, which is not free from irreversibility at higher fields, may be defined as the large anomaly in the specific heat. The transition at H_{c2} is second order and its temperature dependence was investigated from 2.6°K up to $T_c = 9.26$°K. At $T \neq T_c$ the observed $H_{c2}(T_s)$, expressed in κ_1 and h^*, is higher than the theoretical predictions of Maki, Ellenberger, Helfand and Werthamer. The jump in the specific heat $\Delta C(T_c)$ was found to vary at low temperatures as T^3. By means of an Ehrenfest relation, information about the magnetization has been obtained from $\Delta C(T_c)$, which may be compared with the measured magnetization and the predicted temperature dependence of the parameter κ_2. At $T \approx T_c$, both the Maki parameters converge to the GL parameter κ, which is found to be 0.893. κ_0 for pure niobium, from which other microscopic characteristics are calculated, is found to be 0.83. Niobium is found to be an intrinsic type-II superconductor with an electron–phonon coupling of intermediate strength. (auth)

44374 ON THE CRITICAL CURRENT THROUGH A SYMMETRICAL DOUBLE CONTACT BETWEEN TWO SUPERCONDUCTORS AS A FUNCTION OF THE APPLIED MAGNETIC FIELD. De Waele, A. Th. A. M.; De Bruyn Ouboter, R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 42: 626-32(June 12, 1969).

An experiment is reported confirming the relations derived earlier for the critical current–magnetic field dependence of a symmetrical double junction between two superconductors, when the self-induced flux in the area between the contacts is taken into account. (auth)

44375 HYSTERETIC SHIFTING OF THE MAXIMUM CRITICAL TRANSPORT CURRENT IN SUPERCONDUCTING LEAD. Winter, J. J.; Breslin, J. T.; Leupold, H. A. (Inst. for Exploratory Research, Fort Monmouth, N. J.). J. Appl. Phys., 40: 3862-3(Aug. 1969).

Measurements made at 4.2°K on several superconducting lead samples of different purities, geometries, and surface textures show that subjecting the samples to the proper magnetic history results in a shift of the critical current peaks from the usual zero field position to values of peak field as high as 45 G without an appreciable decrease in maximum critical current. In some cases it is possible to shift the peaks to even higher field values, sometimes as high as 160 G. In these cases, however, a concomitant decrease in maximum critical current is observed as the peak field goes above 45 G. Peak shifting was observed in both solid samples and pressure contacts composed of a hemispherical surface pressed against a planar surface. (M.H.R.)

Plasma and Thermonuclear Physics

44376 (CONF-680113-(Vol.5)) 2nd INTERNATIONAL CONFERENCE ON THE INTERACTIONS BETWEEN OSCILLATING FIELDS AND PLASMAS, SACLAY, FRANCE, JANUARY 15–19, 1968. VOLUME V. ORIGINAL SOVIET WORKS. (Institut National des Sciences et Techniques Nucleaires, Saclay (France)). 269p. (In Russian).

Separate abstracts were prepared for the 9 included papers. (M.O.W.)

For abstracts of individual papers see: 44381–44385, 44447–44449, and 44465.

44377 (NP-17989) WILLS PLASMA PHYSICS DEPARTMENT SEVENTEENTH SIX-MONTHLY PROGRESS REPORT, 1st JANUARY–30th JUNE 1969. (Sydney Univ. (Australia). School of Physics). 8p. Dep. CFSTI (U. S. Sales Only).

A brief discussion of research is given for the following: (1) plasma sources, (2) hydromagnetic ionizing fronts, (3) plasma centrifuge, (4) decay in a plasma, (5) hydromagnetic wave propagation in axially nonuniform magnetic fields, (6) laser diagnostics, and (7) far-infrared laboratory. (M.O.W.)

44378 PLASMA PHYSICS: TECHNOLOGY INDEX. VOLUME 3, NO. 7, 1969. Bibliography, Author Index, Subject Index, and Appendix. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 125p.

293 articles on various aspects of plasma physics are listed. (M.O.W.)

Confinement and Heating

44379 (AEC-tr-7055) STUDIES OF ELECTRON HEATING MECHANISM DURING ELECTRON BEAM INTERACTIONS WITH PLASMA. Karkhov, A. N. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translation of report IAE-1630. 31p. Dep. CFSTI.

An abstract of the original Russian report appears in NSA 23: 3438. (L.M.T.)

44380 (AEC-tr-7066) PLASMA ABSORPTION OF HIGH-FREQUENCY ENERGY NEAR THE LOWER HYBRID FREQUENCY. Galaktionov, B. V.; Golant, V. E.; Piliya, A. D.; Shcherbinin, O. N. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report FTI-136. 7p. Dep. CFSTI.

The experiments were performed in an open trap with a mirror configuration of the magnetic field. The plasma was created by shf power from the end of the device. The results obtained are as follows: independence of the maximum absorption frequency with respect to length of coil and angle of inclination of the exciting winding to the magnetic field and an increase in the maximum absorption frequency as the longitudinal component of the density gradient increases. (M.O.W.)

44381 (CONF-680113-(Vol.5), pp 1-39) HIGH-FREQUENCY WAVE EFFECTS ON THE SHAPING AND HEATING OF PLASMA

IN A HIGH-FREQUENCY MAGNETIC FIELD. Golant, V. E. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). (In Russian).

Very-high-frequency waves in the 3-cm range were used for shaping and heating the plasma, introducing the energy into the plasma by a wide-band waveguide system. The range of existence of the plasma in a homogeneous magnetic field and in magnetic traps with a helical configuration was determined as a function of the supplied power and the gas pressure. The main experiments were carried out in hydrogen. It was found that the range of existence of the plasma depends on the absorption of the high-frequency waves. At low electron concentrations, the absorption in the cyclotron-resonance range controls the process; near the critical concentration, the absorption depends on hybrid resonances, reaching an efficiency of 80 to 90%. Beyond the critical concentration, when the plasma frequency is higher than the field frequency, the absorption of the waves in the magnetic field is higher than the cyclotron absorption. When the power applied ranges from a few watts to several tens of kilowatts in 1 liter, at a pressure of 10^{-5} to 10^{-2} mm of Hg, a plasma with a charged-particle concentration of 10^{9} to 10^{14} cm^{-3} and an electron temperature of up to 100 eV were obtained. (TTT)

44382 (CONF-680113-(Vol.5), pp 41-75) TURBULENT HEATING OF PLASMA BY ELECTRIC CURRENT. Zavoiskii, E. K.; Rudakov, L. I.; Fanchanko, S. D. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

Experiments on the turbulent heating of plasma in closed traps were started in 1962; the history of this project at the Kurchatov Institute is outlined. It was found that when the current passes through the plasma, the conductivity of the plasma becomes abnormally low, resulting in the excitation of intense, high-frequency oscillations. The turbulent plasma thus obtained has a high electron and ion temperature that cannot be generated at the present time by pair collisions. The threshold value of the instability was determined experimentally, but additional data are needed concerning the oscillation spectrum of the plasma, the critical electron stream velocity, and the electron and ion distribution functions. The efficient turbulent heating is expected to replace Joule heating when high temperatures must be obtained; it represents a practical application of the turbulent character of the plasma. (TTT)

44383 (CONF-680113-(Vol.5), pp 77-84) NONLINEAR THEORY OF THE TURBULENT HEATING OF PLASMA BY LOW-FREQUENCY ELECTROMAGNETIC WAVES. Sizonenko, V. L.; Stepanov, K. N.; Teichmann, I. (Akademiya Nauk Ukrainsoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). (In Russian).

The linear theory of cyclotron and Cherenkov attenuation of waves and collision effects are not sufficient to explain the results of earlier experiments on the heating of plasma by high-amplitude ion-cyclotron and magneto-acoustic waves, in which a strong absorption of wave energy and a rapid heating of the plasma were observed. The effects are attributed to the development of beam instability of the plasma in the electric field of the electromagnetic wave. It is shown that, as a result of electron-acoustic instability, the ion component of the plasma is rapidly heated by the electric field of ion-cyclotron or magneto-acoustic waves. In case of forced oscillations, when the amplitude of the heating wave is supported by lateral currents, the amplitude must be increased in order to make the heating continuous. Turbulent heating occurs when the thermal energy of the ions is not equal to the energy of the heating field. After this temperature is reached, the turbulent heating process ceases for all practical purposes. (TTT)

44384 (CONF-680113-(Vol.5), pp 107-11) MAGNETIC PUMPING OF INHOMOGENEOUS COLLIDING PLASMA. Nemov, V. V.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSSR, Kharkov. Fiziko-Tekhnicheskii Institut). (In Russian).

The heating of a radially nonhomogeneous cylindrical plasma in a longitudinal magnetic field by a low-frequency electromagnetic field was examined; azimuthal electric currents were used to create the electromagnetic field. Simple analytical expressions based on two-component magnetohydrodynamics were derived to describe the energy absorbed by the plasma. It was found that heating of the plasma up to a given temperature by magnetic pumping, using weak high-frequency fields, requires a time much longer than the time of ion-ion collisions at that temperature. As the time of heating is too long, the "turbulent" type heating methods appear to be more attractive. (TTT)

44385 (CONF-680113-(Vol.5), pp 229-51) EXPERIMENTS ON THE CONFINEMENT AND STABILITY OF PLASMA IN STRONG VERY-HIGH-FREQUENCY FIELDS. Gorbunov, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). (In Russian).

Experiments were carried out at the Accelerator Laboratory on the interaction of plasma with strong vhf fields. A circular waveguide and a cylindrical resonator were used to confine the plasma by such fields. The results indicated that, in rarefied plasma at its highest density, the Langmuir electron frequency, $\omega_{Le\ max}$, is much lower than the field frequency, ω_0. This may be explained by means of the generalized vhf potential. The behavior of the plasma may be due to the vhf field or to the increase of the density of the plasma up to the critical value, $\omega_0 \sim \omega_{Le\ max}$. The field frequency was 10^{10} Hz. The experiments included vhf field configurations that could be used for confining the plasma; in a second set of experiments, the plasma stream was allowed to pass through a given field configuration, investigating its motion and stability. (TTT)

44386 USE OF THE M AND S CONFIGURATION IN THETA PINCHES. Wolf, G. H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 24a: 998-1021(June 1969).

The M & S configuration gives equilibrium for a toroidal plasma without net current in the azimuthal direction and without rotational transform. Explicit solutions are obtained only for the restricted cases $\beta = 0$, and $\beta \leq 1$ in the surface current model, but configurations with continuous pressure profile are proved to exist. The use of the M & S configuration to confine a toroidal theta pinch plasma leads to problems in the establishment of the equilibrium and in particular in its stability. The stability of the M & S configuration is investigated for the simplified case of the corrugated linear theta pinch, LIMPUS. This configuration is theoretically unstable with respect to $m \geq 1$ flutes. Mechanisms to suppress these modes are based on finite gyroradii stabilization for $m \geq 2$, and on the conducting wall for $m = 1$, the latter case being limited to very high β. No $m \geq 2$ instabilities are observed experimentally, although $m = 1$ instabilities with growth times agreeing with MHD theory are detected. An extrapolation of these results to an M & S configuration gives $\tau_{M\&S}/\tau_D \approx (\xi_0/r_p)^{1/4}$, where r_p is the average minor radius, ξ_0 an initial deviation from the M & S equilibrium position, and $\tau_{M\&S}$ and τ_D are the M & S confinement time and the toroidal drift time, respectively. M & S experiments with theta pinch plasmas near 10 eV, $\tau_{M\&S}$ is extended by a factor 3 to 4 beyond τ_D, which is in agreement with the above relation. This suggests first, that the M & S configurations investigated are an adequate approximation to the required equilibrium, and, second, that the MHD instabilities substantially limit the confinement time. Simple models show that oscillating axial currents, a steady axial motion of the LIMPUS magnetic field configuration or a standing-wave-like oscillation can suppress the instabilities mentioned. Experiments on such dynamic stabilization are in progress. (auth)

44387 PLASMA CONFINEMENT IN CUSP GEOMETRY. Belitz, H. J.; Kugler, E. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch., 24a: 977-90(June 1969). (In German).

In order to study the behavior of a theoretically MHD-stable spindle cusp plasma, produced and heated by means of a fast rising magnetic cusp field (B_{max} = 75 kG), various diagnostic techniques were used to measure the plasma parameters (the radius R and the shape of the plasma; the electron and ion temperature T_e and T_i density n). During the time of observation ($\approx$12 μsec) the plasma shape does not change and no MHD instabilities could be detected. Because of cusp losses, however, density and temperatures decay to about 30 to 50% of their maximum values (T_e = 145 eV, T_i = 255 eV, n = 3.8×10^{16} cm^{-3}). There is experimental evidence that the loss areas of line and point cusps are nearly equal. The experimental results are fairly well described by a two-fluid model of Hobbs and Spalding if the total loss area is put equal to $1.2 \times 2 \pi R r_i$ (r_i = mean ion Larmor radius on the plasma boundary). (auth)

44388 ELECTRON-CYCLOTRON HEATING BY 8-mm MICROWAVE POWER IN THE MAGNETIC FACILITY ELMO. Dandl, R. A.; Eason, H. O.; Edmonds, P. H.; England, A. C. (Oak Ridge National Lab., Tenn.). pp 181-203 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

Recent experiments in ELMO employing continuous wave microwave power in a high-mode cavity have shown several surprising features. The high-energy electrons in which most of the energy resides are found primarily in an annulus near the cavity walls and have sufficient density to cause an approximately 40% depression of the vacuum field. The electron-cyclotron plasma is created in a 2:1 mirror field with up to 2 kW of 8-mm microwave power. The belt of electrons from 3 to 4 cm in radial extent at a radius of approximately 9 cm creates the field depression. Flux coils placed around the microwave cavity indicate up to 60,000 maxwells flux change when the microwave power is turned off. A flux coil inserted into the center of the cavity shows a field increase when the microwave power is on, indicating that the plasma is in the form of an annulus and that small energetic electron

orbits (plasma) rather than large concentric orbits (ring currents) are responsible for the manifest energy parameters, such as high β and large Coulomb dissociation neutron flux. Some of the effect, however, is apparently due to drift currents around the axis. Neutron production from Coulomb dissociation of deuterium allows a measure of the number of electrons above 2.2 MeV, thereby providing distribution function information. Radial and axial profiles of the high-β belt were computed from spatially dependent diamagnetic measurements. Comparison of the total stored energy measured diamagnetically with the energy resident in the electrons that produce neutrons indicates the average electron temperature to be well below 2.2 MeV. (auth)

44389 PLASMA CONFINEMENT IN A TOROIDAL QUADRUPOLE. Yoshikawa, Masaji; Ohkawa, Tihiro; Schupp, Arthur A. (Gulf General Atomic Inc., San Diego). Phys. Fluids, 12: 1926-38 (Sept. 1969).

The confinement of plasma in a toroidal quadrupole configuration is studied. The plasma parameters are, ion temperature = 50 eV, electron temperature = 6 eV, and plasma density 10^{13} to 10^{7} cm^{-3}. The confinement times in terms of Bohm diffusion time range from 20 to 40. The loss of the plasma is to the walls. The plasma fluctuations present in large amplitudes are the most likely cause of plasma loss. The superposition of a toroidal field reduces the plasma loss. (auth)

44390 PLASMA INJECTION AND TRAPPING IN A CAULKED STUFFED CUSP MAGNETIC FIELD. Burkhardt, Louis C.; DiMarco, Joseph N.; Karr, Hugh J. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 1894-1903 (Sept. 1969).

A minimum-average-B-stable toroidal magnetic well with high shear is obtained from the combined fields of a solenoid, axial conductors, and an internal ring conductor. Results of measurements of the injection and trapping of high-energy plasma from a coaxial gun are described. The confinement times are dependent on both particle energy and magnetic field. The density e-folding time is independent of the ion velocity under conditions of low shear and well depth. As they are increased the e-folding time varies roughly as $1/v_i^2$. Trapped 0.9-keV plasma decays with an e-folding time that increases by a factor of 6 to 110 μsec as shear and magnetic well depth increase. The initial density of the plasma (0.5 to 3 keV) is $\sim 5 \times 10^{11}$ cm^{-3} for field magnitudes resulting in a 40-μsec lifetime of 0.9-keV deuterons. This lifetime is independent of density over the range from $\sim 5 \times 10^{11}$ cm^{-3} to 10^{9} cm^{-3}. The range of magnetic field magnitude is limited by the decreasing amount of plasma injected from the gun with increasing magnetic fields. The maximum lifetime of 110 μsec is commensurate with the combined effects of the ~370 μsec support lifetime, a calculated ~1000 μsec charge exchange time, and an anomalous lifetime of ~190 μsec. A search for fluctuating electric fields that might be associated with such an anomalous loss shows the presence of low-amplitude 2-MHz oscillations but their possible role as a loss mechanism is not identified. (auth)

Diagnostics

44391 (AD-687283) CALCULATED STARK PROFILES FOR THE He λ 4471 A LINE AND ITS FORBIDDEN COMPONENTS. Gieske, Harry A. (Harry Diamond Labs., Washington, D. C.). Dec. 1968. 56p. (HDL-TR-1406). CFSTI.

Radiation emitted by a hot, partially ionized plasma is indicative of the conditions within the plasma. The energy levels of the constituent atoms are perturbed by the microelectric fields of the ions and electrons, so that the emitted spectral lines are broadened by the Stark effect. The Stark profile of the 2 (3)P-4 (3)L, L = 1, 2,3 transition was calculated for a range of electron densities between 10^{16} and 10^{18} cm^{-3} and for temperature between 10,000 and 40,000°K. The quasi-static approximation was used for ion effects, and a generalized impact approximation was used to describe the electron effects. Tabulated profiles that include the fine structure of the lower state are presented. Error estimates show that the profiles are accurate to about 10%. (auth) (USGRDR)

44392 (AEC-tr-7068) CALORIMETRIC MEASUREMENT OF SUPERHIGH-FREQUENCY POWER. Tsopp, L. E. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17749. 14p. Dep. CFSTI.

An abstract of the original Russian report appears in NSA 23: 12763. (L.M.T.)

44393 (PB-184132) SPECTROSCOPIC MEASUREMENT OF TEMPERATURES IN AN ARGON PLASMA ARC. Bott, J. F. (Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics). Dec. 1965. 29p. (TR-24). CFSTI.

Temperature profiles across the Poiseuille plasma arc were calculated from measured radiation intensities from the atmospheric argon plasma at arc currents from 1 to 400 A. The transition probabilities for several neutral argon lines were calculated from the measurements. The investigation shows the central core of the arc to be in local thermodynamic equilibrium but the sides of the arc to deviate from local thermodynamic equilibrium. The extent of this deviation was found to increase with decreasing current. (auth) (USGRDR)

44394 TEMPERATURE OF A LASER-HEATED CARBON PLASMA. David, C. D, Jr.; Weichel, H. (Air Force Weapons Lab., Kirtland AFB, Albuquerque, N. Mex.). J. Appl. Phys., 40: 3674-9(Aug. 1969).

The temperature of a laser-heated carbon plasma, formed by the interaction between a Q-switched ruby laser and a pyrolytic graphite slab, has been measured using interferometric, spectroscopic, and energy conservation techniques. Results indicate that the maximum plasma temperature is less than 10 eV. A method of determining whether the plasma is in thermodynamic equilibrium is employed and indicates that, at laser fluxes of 10^{9} W/cm^{2}, the plasma is not in LTE with the electron temperature nearly an order-of-magnitude larger than the plasma temperature. For fluxes of 10^{10} W/cm^{2}, however, the plasma appears to approach a state of thermodynamic equilibrium with a temperature of 2 eV. (auth)

44395 COAXIAL SNOWPLOW DISCHARGE. Butler, T. D.; Henins, I.; Jahoda, F. C.; Marshall, J.; Morse, R. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 12: 1904-16(Sept. 1969).

The development of a coaxial plasma discharge in an initially uniform gas filling was studied experimentally and theoretically. In the experiment, the usual outer coaxial electrode was replaced by a current return at the rear of the system, permitting unobstructed access to the discharge for the diagnostics. These diagnostics were image converter photography, magnetic probes, and holographic interferometry. The theory consists of two parts: two-dimensional (axisymmetric) time-dependent fluid computations and a supplementary analytic model, both of which assume that the vacuum magnetic field and the plasma are separated by a sharp interface; the experiments and computations are in good agreement on all gross features of the discharge leading up to the formation of a plasma focus and bubblelike structure in the shock front at the outer end of this focus. (auth)

44396 ELECTRON TEMPERATURE OF A PARTIALLY IONIZED GAS IN AN ELECTRIC FIELD. Robben, F. (Atkiebolaget Atomenergi, Studsvik, Sweden). Phys. Fluids, 12: 1945-7 (Sept. 1969).

The effect of higher-order corrections in the Chapman–Enskog theory on the electron temperature is discussed, and some results are given for plasmas with power-law cross sections. (auth)

44397 ELECTRON TEMPERATURES FROM He I INTENSITY MEASUREMENTS. Johnson, L. C.; Hinnov, E. (Princeton Univ., N. J.). Phys. Fluids, 12: 1947-9(Sept. 1969).

Data are presented relating the intensity of the λ 5876 Å line of He I to electron temperature for use in electron thermometry of plasmas in the range $2 \text{ eV} \lesssim T_e \lesssim 10 \text{ eV}$ and $10^{10} \text{ cm}^{-3} \lesssim n_e \lesssim 10^{14} \text{ cm}^{-3}$. (auth)

44398 PLASMA DIAGNOSTICS WITH A FABRY–PEROT RESONATOR. Seshadri, S. R. (Univ. of Wisconsin, Madison). Proc. IEEE (Inst. Elec. Electron. Eng.), 57: 1187-8(June 1969).

The diagnostics of anisotropic plasma with the help of a Fabry–Perot resonator are discussed for an arbitrary orientation of the static magnetic field. It is noted that the choice between the plane wave and the beam mode approximations for use in the perturbation analysis is not crucial to the experiment and can be avoided by resorting to an additional calibrating measurement. (auth)

44399 SPECTROSCOPIC MEASUREMENTS OF WEAKLY IONIZED ARGON PLASMA JET. 3. STUDY ON SPECTRAL RADIATION OF NEUTRAL ARGON ATOM IN WEAKLY IONIZED ARGON FREE JET. Kamimoto, Goro; Shirai, Hiroyuki (Kyoto Univ.). Nippon Koku Gakkaishi, 17: 267-73(July 1969). (In Japanese).

The properties of spectral radiation from weakly ionized argon plasma jet were measured by the spectroscopic method in the arc-heated plasma jet wind tunnel. It is shown that spectral radiation intensity of neutral argon atom decreases as electron temperature increases, is proportional to electron density cubed, and is independent of metastable argon atom density under the experimental conditions. So it is concluded that spectral radiation is caused by a three-body recombination excitation process (collisional–radiative recombination process). (NSA of Japan)

44400 EFFECT OF ELECTRON HEATING ON THE ELECTRON TEMPERATURE PROBE. Hirao, Kunio; Oyama, Koichiro (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 5: 441-9(July 1969). (In Japanese).

When a high-frequency potential, whose frequency is fairly lower than the electron plasma frequency, is applied to a probe, the dc component varies according to the nonlinear characteristics of the sheath. This fact is well known and many papers have been presented. However, in this lower frequency range, the sinusoidal potential applied to a probe seems to heat the electron in the plasma around a probe, considering the fact that the measured electron temperature increases. So the theory presented so far seems to need some corrections. In the present paper, a new expression of the characteristic curve of a high-frequency superposed probe is presented, considering an effect of intrusion of electric field at the boundary of the ion sheath around a probe. (NSA of Japan)

44401 ELECTRICAL CONDUCTION FROM A COLD ELECTRODE TO A SUPERSONIC PLASMA. Schwirian, Richard Earl. Cleveland, Case Western Reserve Univ., 1968. 156p.

Thesis.

Numerical solutions are obtained for the quasi-one dimensional flow of electric current from a flat plate probe to a shock-heated argon plasma. The governing equations are derived by taking "moments" of the Boltzmann equation. The moments considered are the atom, ion and electron continuity, momentum, and heat flux moments, together with atom and electron energy moments. Ion and atom temperatures are assumed to be equal so that an ion energy equation is not required. The gas is assumed to be slightly ionized, thereby allowing the atom temperature distribution to be calculated independently. Effects of charged-particle collisions, ionization and recombination, and secondary "Auger" emission on the ion–electron flow are taken into account. Calculations are performed for typical shock tube conditions. The effects of current density, free stream temperature, and distance from the leading edge on electron number density and temperature profiles are discussed. Finally, computations of current density–voltage characteristics are made with and without secondary emission effects included and presented graphically. (Diss. Abstr.)

44402 NEW TECHNIQUE FOR MEASURING THE DISTRIBUTION OF THE OPTICAL THICKNESS OF NONSTATIONARY PLASMA COLUMNS. Bortfeldt, J.; Meiners, D.; Weber, W.; Wittig, L. (Technische Univ., Hanover). Z. Angew. Phys., 27: 240-3(July 14, 1969). (In German).

A technique for determination of the complete lateral distribution of the optical thickness of rapidly varying plasmas by a single high-speed photographic measurement was developed. It was applied to an exploding-wire plasma; accuracy and further applications are discussed. (auth)

Kinetics (General)

Refer also to abstract 44711.

44403 (AEC-tr-7061) ON THE POSSIBILITIES FOR USING HIGH-CURRENT RELATIVISTIC BEAMS IN PLASMA PHYSICS. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 23. 28p. Dep. CFSTI.

Studies on the following are described: (1) instability of relativistic beams in a plasma, (2) normal and anomalous scattering of light by a relativistic beam, (3) possibility for amplification of uv and γ quanta by a beam of relativistic electrons in the presence of a high-intensity light beam, (4) the Cherenkov laser, (5) resonant buildup of electromagnetic waves in lines and evaluation of the effectiveness of excitation of levels by a relativistic beam, and (6) the synchrotron laser and synchrotron instability. (M.O.W.)

44404 MEASUREMENT OF LIGHT SCATTERED FROM DENSITY FLUCTUATIONS WITHIN A COLLISIONLESS SHOCK. Paul, J. W. M.; Daughney, C. C.; Holmes, L. S. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature (London), 223: 822-4(Aug. 23, 1969).

The light forward scattered from a 50-MW ruby laser beam of diameter 2 mm during the passage of a shock through the beam was studied. The collisionless shock was produced by radial compression of an initial hydrogen plasma within a linear Z pinch (see Nature 208: 133 (1965) and 216: 363 (1967)). The currently accepted theories of such shocks invoke ion-wave turbulence to explain the structure and collisionless heating. When light is scattered by plasma waves the change of optical wave vector and frequency from incident to scattered light is equal to the plasma wave vector and frequency, and the differential scattering cross section per electron measures the level of density fluctuation in terms of its Fourier transform. In the experiment described, the scattered light, measured by a photomultiplier, appeared as a pulse much shorter than the laser emission, and corresponded in time and duration with the passage of the shock through the laser beam. There was clearly an enhanced level of scattering and, consequently, of ion wave fluctuations within the shock. The scattering produced a change of wavelength $\Delta\lambda < 1.5$ Å, and must have arisen from plasma fluctuations with frequencies appreciably less than the electron plasma frequency. All the scattered light lay within the wavelength range ±0.15 Å from the centre of the ruby line. The average scattering cross section within the shock was measured by comparing the power scattered from the shock with that Rayleigh scattered from nitrogen. The free-energy driving instabilities must be associated with the current flow or the inhomogeneities within the shock, and the measured level of fluctuation can be used to estimate the total energy in the turbulence, assuming that it is isotropic, yielding a value which is 9% of the electron thermal energy. Estimations were made of the effective collision frequency resulting from the turbulence. It is concluded that experimental evidence was obtained for a self-consistent model of a collisionless shock based on ion wave turbulence. (UK)

44405 INVESTIGATION OF MICROWAVE INTERACTION WITH A PLASMA CONFINED IN A DIPOLAR MAGNETIC FIELD. Twardeck, Thomas George. University Park, Pa., Pennsylvania State Univ., 1968. 119p.

Thesis.

Properties of a plasma confined in the dipolar magnetic field of a uniformly magnetized sphere were investigated. The main diagnostic tools were microwave interferometers operating at 3.0, 1.34, and 0.86 cm. Laboratory measurements included changes in received power and phase for various plasma densities, scattering angles and frequencies, and changes in the received power for different pressures in the vacuum vessel, plasma densities and frequencies. The assumptions used in formulating a theoretical model of the experiment are stated and examined for validity. Consistent with these assumptions, an idealized model of the scattering geometry is presented and expressions for the scattering coefficients and scattered field quantities are formulated in terms of the plasma parameters. The digital computer techniques for evaluating the appropriate expressions are described, and the influence of each physical parameter on the calculations is considered. Comparison of the simple theoretical model with experimental results indicates that in forward scattering angles the plasma is accurately described as a plasma shell characterized by a constant complex refractive index for the plasma densities, collision frequencies, and incident wave frequencies encountered in the laboratory investigation. The electron density profiles synthesized from the scattering data are in agreement with the density profiles determined by double Langmuir probe measurements. (Diss. Abstr.)

Kinetics (Experimental)

44406 (AD-686374) OBSERVATION OF SURFACE MODES EXCITED BY AN ELECTRON BEAM IN A PLASMA. Bohmer, H.; Raether, M. (Illinois Univ., Urbana. Coordinated Science Lab.). Apr. 1969. Contract DAAB07-67-C-0199. 15p. (R-411). CFSTI.

Unstable oscillations at frequencies below the plasma frequency are observed at the plasma boundary during the interaction of an electron beam with a plasma. These oscillations are interpreted as the eigenmodes of the inhomogeneous plasma boundary, driven into instability by the beam. (auth) (USGRDR)

44407 (AEC-tr-7082) METHOD OF EXTERNAL INJECTION OF ELECTRONS INTO CLOSED TOROIDAL SYSTEMS. Andryukhina, E. D.; Fedyanin, O. I.; Khol'nov, Yu. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17743. 7p. Dep. CFSTI.

An abstract for the original paper appeared previously in NSA 23: 12741. (M.O.W.)

44408 EXTERNAL EXCITATION OF SPACE CHARGE WAVES IN RF DISCHARGES. Sugai, Hideo; Sato, Noriyoshi; Hatta, Yoshisuke (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 27: 746-58(Sept. 1969).

In rf discharges of 14 to 50 Mc/sec under an axial magnetic field up to 100 G, waves are excited by applying sinusoidal currents of 1 to 100 kc to a small coil surrounding the discharge tube. The waves exhibit standing-wave patterns, in spite of absence of reflection, along the plasma column. The wavelengths are independent of the ion mass density and the coil current frequency. They are proportional to the plasma radius, the magnetic field intensity, and the inverse of the discharge frequency. Agreement is found with the theory for space-charge waves in a bounded plasma, whose frequencies are equal to the discharge frequencies. Those space-charge waves, modulated in amplitude, are shown to be excited by the local density modulations produced by the coil currents in the presence of the rf discharge field. The standing-

wave patterns are attributed to the synchronization of the waves with the rf discharge field. (auth)

44409 STABILIZED GUN FOR PLASMA INTERACTION STUDIES. Matt, D. R.; Markovic, Petar; Scott, F. R. (Univ. of Tennessee, Knoxville). J. Appl. Phys., 40: 3863-4(Aug. 1969).

A titanium-washer gun to produce moving plasmas with a small angular divergence without a guide field is briefly described. The plasma parameters of the modified gun were measured as a function of the working conditions of the system and the results reported here indicated improvement in desired plasma parameters and better shot-to-shot reproducibility. (M.O.W.)

44410 DEVELOPMENT OF SPARK DISCHARGES IN HYDROGEN. Cavenor, M. C.; Meyer, J. (New England Univ., Armidale, Australia). Aust. J. Phys., 22: 155-67(Apr. 1969).

Streak photography has been used to supplement the earlier shutter photographic investigation of Doran and Meyer (1967) using the same coaxial cable discharge circuit. Additional information has also been obtained from measurement of the potential distribution between the electrodes at two states in the spark development. Redistribution of space charge is shown to give rise firstly to a transient diffuse glow discharge that has a close similarity with a normal dc glow discharge. It has also been shown that, even while the diffuse glow discharge expands, a partial constriction occurs in which most of the current flows along a narrow axial column. The resulting maximum in electron density eventually causes a rapid increase in dissociation of molecular hydrogen on the axis of the discharge brought about by a rise in the gas temperature. Owing to its greater electrical conductivity this axial column soon carries the entire current and the discharge becomes filamentary though still being maintained by a high cathode fall field, which exists until a sudden change in the cathode mechanism gives rise to the low-voltage arc channel. Both the filamentary glow and arc columns are observed to expand according to an $r \propto t^{\frac{1}{2}}$ law. (Australia)

44411 DISPERSION AND STABILITY OF MOVING STRIATIONS. Garscadden, A. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Bletzinger, P.; Simonen, T. C. Phys. Fluids, 12: 1833-44(Sept. 1969).

Experiments are reported on the waves of ionization that can be excited in the low- and medium-pressure discharge in argon, neon, and mercury–argon mixture. The glow-to-arc transition and the change from a forward wave to a backward wave of ionization were studied in detail using a space–time display which immediately reveals the dispersion of the waves. Evidence is also presented for the transition from a convective to an absolute instability. A comparison is made with the Pekarek–Krejci theory of moving striations and using Derfler's stability criteria, calculations are presented to show that this theory predicts both forward and backward waves which can be stable, convectively unstable, or absolutely unstable. (auth)

44412 PROPERTIES OF HIGH SPEED ELECTRONS IN GAS D. C. DISCHARGE AT LOW PRESSURES. Parvan, Radu N. (Univ., Bucharest). Stud. Cercet. Fiz., 21: 489-522(1969). (In Rumanian).

Measurements were made of low- and high-speed electrons in both negative and positive columns, and results are interpreted. (M.O.W.)

44413 NUMBER OF FEATURES OF THE DE-EXCITATION OF A DECAYING DISCHARGE PLASMA IN CESIUM VAPOR. Morgulis, N. D.; Lukashenko, V. I. (Kiev Univ.). Ukr. Fiz. Zh., 14: 507-9(Mar. 1969). (In Russian).

The continuous decrease in the concentration N_e and temperature T_e of electrons in the decay of a discharge plasma should lead to a continuous damping of all processes in the plasma, including de-excitation. However, it has been noted that the de-excitation intensity of two spectral lines has a very complex and nonmonotonic character. Spectral measurements were carried out on an ordinary arc plasma in cesium vapor at various pressures. A plot of intensity ratios versus de-excitation time showed an initial decrease in intensity with a subsequent rise greatly exceeding the initial intensity. The electron concentration and temperature, meanwhile, decreased continuously in a normal manner. In a similar manner, the intensity of the cesium recombination spectrum in the region of the 6P-continuum also decreased monotonically with time. The complex and nonmonotonic de-excitation may be associated with population of a given excitation level during cascade recombination of atomic cesium ions in the discharge plasma. It also may be possible to obtain an inversion in population of the upper excitation levels of cesium. The problem is being studied further. (TTT)

44414 INTERACTION OF A MOVING PULSE PLASMA WITH A NONMOVING PLASMA FROM A QUASI-STATIONARY DISCHARGE. Chutov, Yu. I. (Kiev Univ.). Ukr. Fiz. Zh., 14: 514-17(Mar. 1969). (In Russian).

In electric shock tubes, radiation and fast electrons from the gas-discharge plasma leave behind the shock front, and ionize the gas in front of the wave. Consequently, the moving pulse plasma interacts not with a neutral gas but with a weakly ionized plasma. To study this advance plasma, a moving plasma was created by a fast condenser discharge, and a nonmoving plasma of 50-cm length was created by a quasi-stationary exponential discharge of a battery of condensers through a resistance R = 8 ohms. The fast discharge was turned on 5 msec after the start of the quasi-stationary discharge, when the concentration of charges at electron temperature were 4×10^{13} cm^{-3} and 2×10^{4} °K, respectively. By means of photoelectric readings it was possible to investigate the change in luminescence intensity of the argon gas with time in the spectral region of about 4850 Å at different points along the axis of the tube. A sharp luminescence peak was associated with a perturbation being propagated in the quasi-stationary plasma. This perturbation is caused by a shock wave being propagated in the plasma. (TTT)

Kinetics (Theoretical)

44415 (AD-687862) THEORY OF ELECTRIC ARCS WITH RADIAL MASS INFLOW. Final Report. Druxes, Herbert (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Jan. 1969. 167p. (ARL-69-8). CFSTI.

In order to determine the applicability of a single-component approach to the problem of an arc with radial mass inflow, a detailed discussion of the basic electrodynamic and gasdynamic equations is presented. Appropriate comparisons among the nondimensionalized parameters allow one to make certain simplifications for low Mach numbers. The results indicate that specific dimensionless quantities appear which characterize the operating range for this type of arc. For a laminar, stable, rotationally symmetric arc with uniform radial mass inflow, an exact numerical solution is made which is then compared with a particular model theory. This model theory assumes that the gas density and viscosity are known as functions of the radius and the boundary conditions at the tube wall. Good agreement is found between the numerical solution and the model theory. One also concludes that radial mass inflow can remarkably reduce the heat flux to the walls thus leading to higher axis temperature for the same electric power input. (auth) (USGRDR)

44416 (AEC-tr-7060) THEORY OF LOW-FREQUENCY ELECTROMAGNETIC PROPERTIES OF A TURBULENT PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 172. 29p. Dep. CFSTI.

An approach is developed based on expansion of integrals for the collisions of plasma particles and turbulent pulsations with respect to the energy of turbulence. The dielectric constant of the plasma is found within the framework of this approach in the first approximation with respect to the energy of turbulence, and new types of low-frequency plasma oscillations are investigated. In particular, it is shown that in a low-frequency plasma at turbulence energy W greater than the critical value W_{cr} ($W_{cr} \ll nT$), oscillations of the acoustic type may be propagated at a velocity which depends on the turbulence energy. Criteria are elucidated for the applicability of the approach based on expansion of the integrals for turbulent collisions with respect to turbulence energy. It is shown that these criteria impose very rigid conditions on the possibilities for manifestation of instabilities in the longitudinal (potential) perturbations of a turbulent plasma. An approach is developed for computing the integrals of particle collisions and turbulent pulsations. This approach is based on taking account of the weakness of correlations of turbulent pulsations with each other and with perturbations of the turbulent pulsations. An integral equation is derived for the kernels of the integrals of particle collisions with turbulent pulsations. The solution of this equation allows summation of the series with respect to turbulence energy in the given collision integrals. This integral equation is solved and the dielectric constant is found in the limiting case of Langmuir pulsations of large phase velocities. It is shown that the result reduces to renormalization of the Green's function for the plasmon and the charge of the particles, which is associated with a nonlinear change in the turbulence of the dispersion properties of turbulent pulsations. The resultant dielectric constant is used for studying new instabilities of longitudinal perturbations of a turbulent plasma. It is shown that these instabilities may develop over a wide range of plasma parameters and plasma turbulence, and that they are qualitatively different from those previously studied by expansion of collision integrals with respect to turbulence energy. For purposes of simplification, the presentation is based on magnetized plasma particles ($H \to \infty$).

The general methods developed are independent of this assumption. (auth)

44417 (AEC-tr-7063) QUANTUM SPIN WAVES. Zyryanov, P. S.; Okulov, V. I.; Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Russian Preprint No. 164. 6p. Dep. CFSTI.

The classical theory of spin waves in a nonferromagnetic metal provides for an entire series of restrictions on the possibility of their propagation connected with the existence of collisionless Landau damping. It is shown that due to quantization of the orbital motion of the electrons by a strong external magnetic field, the possibility of the existence of new branches of the spin density oscillation is opened up. (M.O.W.)

44418 (N-69-29905) ENERGY TRANSFER AND ION COST IN A HYDROGEN PLASMA. Monnin, Carl F.; Prok, George M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1969. 19p. (NASA-TN-D-5319). CFSTI.

A Maxwellian electron gas interacts with a cold neutral hydrogen gas with various degrees of dissociation. The electron temperature range is 3 to 100 eV. The plasma is assumed to be tenuous and in the steady state. The power is assumed to be lost by radiation, ionization, and kinetic energy carried to the walls per second by the charged particles. The wall loss term used is calculated from sheath theory. The cost of producing a proton in various mixtures of neutral atomic and molecular hydrogen is also presented. (auth) (STAR)

44419 CHARACTERISTICS OF ROTATIONALLY STABILIZED LONG PLASMA ARCS IN A CHAMBER. Yeh, Hsu-chieh; Yang, Wen-jei (Univ. of Michigan, Ann Arbor). J. Appl. Phys., 40: 3687-93(Aug. 1969).

An analytical method is developed to determine the gas temperature distribution and the electric field strength-arc length characteristics of a rotationally stabilized long plasma arc in a cylindrical chamber. The application of the method was demonstrated by numerical computations which were carried out for a monatomic hydrogen arc stabilized in a very large chamber. The relationships among the electric field strength, current, arc length, and arc-axis temperature are disclosed. (auth)

44420 FAST NUMERICAL PROCEDURES FOR COMPUTER EXPERIMENTS ON RELATIVISTIC PLASMAS. Buneman, Oscar (Stanford Univ., Calif.). pp 205-33 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

The success of computer experiments on nonrelativistic plasmas (bibliography given by Birdsall and Hasegawa, 1966, survey of the topic given by Buneman and Dunn, 1966) suggests that any serious study of relativity effects in plasmas could benefit from similar "experiments" appropriately extended. Indeed, some computer experiments on relativistic plasmas have already been carried out, notably experiments on the Astron E-layer by P. Weiss and others at Livermore and an experiment by R. Burn on the electromagnetic instabilities of the sheet-pinch to be reported in Physics of Fluids. Special symmetries permitted simplifications in the cases studied hitherto, and the conservation of certain canonical momenta facilitated the integration of orbits. (auth)

44421 HEAT AND DIFFUSION FLUXES IN A MULTICOMPONENT IONIZED GAS IN A MAGNETIC FIELD. I. GENERAL EXPRESSIONS. Devoto, R. S. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch., 24a: 967-76(June 1969).

Ordinary and thermal diffusion as well as heat flux in a dilute, ionized, multicomponent monoatomic gas in a magnetic field are considered with the Chapman-Enskog-Burnett method. It is shown how, with certain modifications, the usual expressions for the properties of an un-ionized monoatomic gas may be applied to this case. The expression for the diffusion flux is compared with the momentum equation suggested by Schlüter. (auth)

44422 SUPRA-LUMINOUS PLASMA WAVES AND RADIATION FROM DENSITY INHOMOGENEITIES. Lerche, Ian (Univ. of Chicago). pp 101-54 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

The linearized equations describing the response of the collisionless electron plasma to a test particle fired into the plasma at time t = 0 and otherwise uncorrelated in their positions at time t = 0 are developed. It is demonstrated that as well as the adiabatic result described elsewhere (Rostoker, 1960), there exists a large number of extra terms which have a real physical significance. It is shown that the contribution of supraluminous waves (phase velocities > c) to the energy density are physically significant. The following idealized situation is also considered. The case where electromagnetic radiation is stimulated by longitudinal supraluminous plasma oscillations which are propagating in a uniform plasma and "collide" with a small, localized density inhomogeneity in the thermal plasma is described. The basic model and the equations describing the equilibrium state and small departures from equilibrium are given. A single isolated thermal density inhomogeneity is next considered, and the scattered electromagnetic field is calculated as the result of a "collision" between a single electrostatic wave and the inhomogeneity. The far-field approximation to the electromagnetic field (the radiation term) is calculated. The analysis is extended to cover both a spatially random distribution of particular density fluctuations and the thermal plasma spectrum of supraluminous electrostatic waves, and compute the total power output. The results are applied to simple models of (a) a radio source and (b) a laboratory plasma. It is shown that in the case of the laboratory plasma, the phenomenon is a negligible one but in an astrophysical plasma, it may be important. In the appendix, it is demonstrated that, for one particular isotropic electron plasma distribution function, the branch cut contributions decay exponentially in time and are eventually negligible compared to other terms in the power spectrum. (M.O.W.)

44423 RELATIVISTIC PLASMAS. The Coral Gables Conference, February 1968. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968. 259p. (CONF-680218).

Separate abstracts were prepared for the 9 included papers. (M.O.W.)

For abstracts of individual papers see: 44132, 44388, 44420, 44422, 44424-44426, 44461, and 44474.

44424 COVARIANT DISPERSION THEORY FOR A COLLISIONLESS PLASMA IN A UNIFORM FIELD. Buneman, Oscar (Stanford Univ., Calif.). pp 1-23 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

The following topics are discussed: (1) equilibrium energy-momentum distribution, (2) orientation of the uniform field, (3) perturbations of the Boltzmann function, (4) moments of the distribution function perturbation, (5) the admittance tensor, and (6) genuine relativity effects. (M.O.W.)

44425 SYMMETRIES OF A RELATIVISTIC PLASMA. Kursunoglu, Behram (Univ. of Miami, Coral Gables, Fla.). Contracts NASA NGR 10-007-010; AFOSR F 44620-68-C-0033. pp 25-32 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

Symmetry theory is used to describe a relativistic classical system in a constant external magnetic field. The various plasma modes are described. (M.O.W.)

44426 CAUSALITY AND RELATIVISTIC PLASMA. Santilli, Ruggero M. (Univ., Turin. Univ. of Miami, Coral Gables, Fla.). Contracts NASA NGR 10-007-010; AFOSR F 44620-68-C-0033. pp 33-40 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

Zeeman theory for causality requirements is reviewed. These concepts are applied to relativistic plasma physics. (M.O.W.)

44427 ELECTRON TEMPERATURE EFFECTS IN FAST MAGNETOHYDRODYNAMIC SHOCK WAVES. Leonard, B. P. (Monash Univ., Clayton, Australia). Phys. Fluids, 12: 1816-29(Sept. 1969).

The interaction between magnetic and electron temperature effects is analyzed in the simplest nontrivial case of fast magnetohydrodynamic shock waves in a slightly ionized plasma. This interaction occurs because the magnetic structure and the associated Joule heating are dependent on the variation of electrical conductivity; the latter is affected by the electron temperature structure which depends in turn on the amount of Joule heating in the magnetic layer. The ionization is assumed to be frozen and so slight that the heavy particle structure (including a viscous subshock) is independent of that of the electrons. For negligible Hall currents a nonuniform coordinate stretching formally decouples the magnetic equation from the electron temperature

system; the resulting two-point boundary-value problem is solved by matching asymptotic expansions in the outer magnetic layer and intermediate thermal layer when the respective length scales differ by a factor of about 3. The fine structure of the inner subshock region is not considered. Joule dissipation preheats the electrons in the upstream magnetic layer. Near the subshock the effect of a sudden compression of the electrons due to charge coupling with the heavy ions is diffused by thermal conduction, and there is a collisional relaxation zone downstream. (auth)

44428 ELECTRON TEMPERATURE DISTRIBUTION ACROSS A SHOCK WAVE IN A PARTIALLY IONIZED GAS. Murty, S. S. R. (Indian Inst. of Science, Bangalore). Phys. Fluids, 12: 1830-2 (Sept. 1969).

The electron temperature structure in a weakly ionized plasma is studied allowing the degree of ionization to vary across the shock wave. The values of the electron temperature and the downstream equilibrium temperature obtained with variable ionization are less than those for frozen ionization. The electron temperature rises sharply behind the shock for variable ionization while a gradual increase is predicted by frozen ionization. (auth)

44429 ANOMALOUS FRICTION DUE TO MICROTURBULENCE. Drummond, W. E.; Sloan, M. L. (Univ. of Texas, Austin). Phys. Fluids, 12: 1849-51 (Sept. 1969).

The effects of a stochastic electric field of high frequency and phase velocity on the dynamics of a low-velocity particle is studied. It has been shown that the effect of such fields, to second order in the electric field strength, is to introduce an anisotropic drag force into the equations of the particle dynamics which, as in the collisional case, is linearly related to the particle velocity and vanishes when the autocorrelation time of the statistical electric field vanishes. (auth)

44430 TEST PARTICLE IN A TWO-DIMENSIONAL PLASMA. Abraham-Shrauner, B. (Washington Univ., St. Louis). Physica, 43: 95-104(July 1, 1969).

The diffusion and dynamical friction coefficients were calculated for a test particle in a two-dimensional, one-component, spatially homogeneous plasma. The coefficients for the Fokker–Planck and Balescu–Lenard kinetic equations are compared for the two-dimensional analogue of the Lorentz velocity distribution function. Significant differences between the two sets of coefficients are found. These differences are attributed, in part at least, to the difference of dynamical shielding in two and three dimensions and to the particular choice of velocity-distribution function. (auth)

44431 ENERGY LOSS OF FAST TEST IONS IN A PLASMA. Ray, R. M. (Univ. of Sydney). Phys. Lett., 29A: 577-9(Aug. 11, 1969).

Numerical results are presented for the relaxation of an energetic "test" ion in a plasma. Both cooperative plasma effects and the dynamics of close collisions are treated fully. These results are compared with a recent experiment. (auth)

44432 LORENTZ PLASMA IN AN ELLIPTIC MAGNETIC FIELD. Pop, Gh. G. (Roumanian Academy of Sciences, Cluj). Rev. Roum. Phys., 14: 387-93(1969). (In French).

The Boltzmann equation was solved for a Lorentzian plasma in an elliptical magnetic field, and a distribution function was derived using Legendre polynomials in the first order of approximation. (tr-auth)

44433 JOINT PROBABILITY DISTRIBUTIONS OF THE ELECTRIC MICROFIELD IN HOT PLASMAS WITH NEGLECT OF INTERACTIONS BETWEEN PARTICLES. Dalenoort, G. J. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Physica, 42: 93-110(Apr. 1, 1969).

A calculation is presented for the joint possibility distribution of the electric microfield in an ionized gas. The gas is assumed to consist of particles that do not interact but cause an electric field. The calculation is done for two models, one in which averages are performed over positions of particles, and one over configurations. The first is an outcome of a critical survey of the theories of spectral-line broadening, the second an extension of the Holtsmark distribution. Several cases are considered, joint probabilities in space, in time, and in space and time combined. (auth)

44434 RESPONSE OF A LORENTZIAN GAS TO AN AC PULSE. Ghatak, Ajoy K. (Indian Inst. of Tech., New Delhi). Z. Phys., 226: 454-62(1969).

The response of a "Lorentz gas" to a pulsed ac electric field and its relaxation after the cessation of this field has been studied by solving the Boltzmann's transfer equation. Explicit expressions for the electron distribution function and the current density are obtained under the assumption that the collision frequency is independent of the electron velocity. (auth)

44435 COULOMB INTERACTION AND IONIZATION EQUILIBRIUM IN PARTIALLY IONIZED PLASMAS. Ebeling, W. (Univ., Rostock, Ger.). Physica, 43: 293-306(July 8, 1969).

A recently developed quantum-statistical theory of multicomponent plasmas is applied to a partially ionized gas in thermal equilibrium. The theory is developed on the basis of two different models of the real plasma. From the physical model standpoint the plasma is considered as a system of electrons and singly charged ions. In the chemical model the plasma is assumed to exist as a mixture of free electrons, free singly charged ions, and neutral atoms in chemical equilibrium. Phenomenological and statistical formulae of the thermodynamic functions are derived for both of these models. Convergent expressions are given for the atomic partition function and the ionization constant. Using this "reduced" ionization constant the Debye–Hückel theory is shown to be valid at temperatures below 50,000 K. The equation of state and the degree of ionization for hydrogen plasmas are studied on the basis of numerical calculations. It is shown that the theory developed on the basis of the chemical model gives reasonable expressions for the pressure and the degree of ionization for a wide range of temperatures and densities. (auth)

44436 CALCULATED ENERGY DISTRIBUTION FUNCTIONS AND DRIFT VELOCITIES IN A CESIUM DISCHARGE. Postma, A. J. (EURATOM–FOM, Jutphaas, Netherlands). Physica, 43: 229-229-43(July 8, 1969).

The electron energy distribution function in a discharge in cesium vapor was calculated from the Boltzmann equation. The collision processes taken into account are elastic electron–atom collisions, inelastic collisions leading to the first excited states, and Coulomb collisions between electrons and ions and between electrons mutually. The distribution function is assumed to be time-independent and homogeneous in space. The only external force is the applied electric field. From the distribution functions the electron drift velocities, the average electron energies, and the energy loss rate at excitation of the first excited levels were calculated as a function of the degree of ionization and the ratio between electric field and gas density. (auth)

44437 KINETIC THEORY OF WEAKLY IONIZED TIME-VARYING MAGNETOPLASMAS. Stiller, W.; Vojta, G. (Arbeitsstelle fuer Statistiche Physik, Berlin). Physica, 43: 216-28 (July 8, 1969).

Using Boltzmann's equation a general method is developed for the calculation of the electron distribution function f of a weakly ionized plasma in external homogeneous time-dependent magnetic fields and additional electromagnetic fields. Only elastic collisions are considered. The method implies the formal calculation of the isotropic part $f^0(r,v,t)$ and the direction-dependent part $f^1(r,v,t)$ of f by means of integrodifferential and differential equations. Approximation methods for an explicit calculation of f^0 and f^1 are given. Two classes of plasmas are then considered: (a) homogeneous nonstationary ($\partial f/\partial r = 0$, $\partial f^0/\partial t \neq 0$) and (b) inhomogeneous stationary ($\partial f/\partial r \neq 0$, $\partial f^0/\partial t = 0$) magnetoplasmas. For case (a) the solution for f^0 has a complicated form which is discussed in comparison with papers of other authors treating the problem of higher harmonics in plasmas. (auth)

44438 RELATIVISTIC RING EQUATIONS. I. A PERTURBATIVE APPROACH. Baus, M. (Univ. Libre, Brussels). Physica, 43: 321-52(July 29, 1969).

Using a perturbative approach the finite frequency collision operator for a homogeneous relativistic plasma with electromagnetic interactions is computed within the ring approximation. The kinetic equation for the particle momentum distribution and the radiation transfer equation for the electromagnetic field are derived for various cases. For a strongly stable system previous results are recovered but are shown to be incomplete. Specifically relativistic contributions to the kinetic equation from branch cuts and undamped plasma waves that have hitherto been neglected are discussed. The coupled system of ring equations is derived for unstable relativistic plasmas. (auth)

44439 KINETIC DESCRIPTION OF PLASMA IN AN EXTERNAL FIELD. II. RING APPROXIMATION. Kuszell, A.; Senatorski, A. (Inst. of Nuclear Research, Swierk, Poland). Physica, 42: 587-606(June 12, 1969).

The kinetic equation for a plasma in an external nonuniform and nonstationary electromagnetic field in the so-called ring approximation is derived. The system is described by two coupled equations, the kinetic equation for the one-particle distribution function and the Vlasov equation linearized around the solution of the kinetic equation. The last equation determines an auxiliary function appearing in the collision operator. A method of solution of this equation based on hydrodynamical concepts is proposed. In the zero-order approximation (hydrodynamic approximation) the collision integral is found explicitly. The time evolution of the contribution of an initial two-particle correlation is discussed. (auth)

44440 INFINITIES IN THE STATISTICAL THEORY OF RADIATIVE PROCESSES IN PLASMAS. Laue, H. (Middle East Technical Univ., Ankara). Nuovo Cim., 62B: 334-50(Aug. 11, 1969).

Two kinds of infinities occurring in Prigogine's master equation when it is applied to a system containing charged particles (one electron and N ions) and radiation are discussed. The first kind is caused by the presence of the radiation field since the usual Hamiltonian for an electron and a radiation field necessarily contains also the self-field of the electron, which is infinite on the electron's world line. The entry of this infinity into the formalism is analyzed. The analysis leads to a prescription for rewriting the Liouville operator which allows relativistic and radiation reaction effects to be approximately included and which yields a theory without divergences due to the presence of a radiation field. Another kind of infinity is shown to be present. It occurs upon integrating over the particle co-ordinates, as is necessary for many applications. The immediate cause of this infinity is shown to be an asymptotic time integration employed to derive the master equation. However, reasons are given to show that the asymptotic time integration cannot simply be replaced by some other formalism leading to finite results; the convergence of the series for the momentum distribution function is indeed poor for small relative velocities between electron and ions, so that only the sum of a large number of terms in the series can provide a correct (and finite) result for small velocities. (auth)

Production

Refer also to abstract 44394.

44441 (AD-686104) PREIONIZATION IN NONEQUILIBRIUM PLASMAS. Annual Summary Report. Evans, Norman A. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Mar. 1969. Contract F44620-68-C-0048. 32p. (AFOSR-69-985-TR). CFSTI.

An experimental study of the preionization process in nonequilibrium plasmas has been started in a cesium-seeded argon mixture. The work is being performed in a boron nitride channel containing twelve electrode pairs, each equipped with a discharge holder at a gas stagnation temperature of 1500°K, Mach numbers up to M = 0.6, and transverse magnetic field strength up to B = 22,500 G. For discharge currents of 3 A, the results showed that steady, stable behavior was obtained up to M = 0.6 for B = 0, with the discharge holders fully effective in controlling the current path. However, discontinuous increases in electrode voltage were observed with magnetic field, and on the basis of probe readings it was concluded that the first discharge had jumped to the next adjacent holder downstream. (auth) (USGRDR)

44442 (AEC-tr-7057) PLANAR PLASMA SOURCE. Gol'ts, E. Ya.; Turundaevskii, V. B.; Khodzhaev, A. Z. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17746. 18p. Dep. CFSTI.

An abstract of the original Russian report appears as NSA 23: 12867. (L.M.T.)

44443 (N-69-29140) PLASMA GENERATION USING A LARGE V-GROOVE CATHODE DISCHARGE. Caron, Paul R. (National Aeronautics and Space Administration, Cambridge, Mass. Electronics Research Center). June 1969. 37p. (NASA-TN-D-5269). CFSTI.

The results of an investigation of the plasma parameters generated by a large V-groove cathode discharge are presented. The cathode consists of a 12-inch aluminum plate into which V grooves of $\frac{1}{8}$-inch spacing and 60° angle are milled. With this cathode, a negative glow discharge is produced that yields a stable, steady-state plasma. Electron densities up to 2×10^{12} cm^{-3} have been obtained in the 12-inch diameter chamber. The electron temperature is about 1200°K and is independent of discharge current and gas pressure over the range 0.3 to 1.0 torr. The discharge operates in much the same fashion as a conventional brush cathode discharge but with lower operating voltage for equal current densities. The lower operating voltage, which reduces the arcing problems at the cathode-glass junction, and the relative ease in fabricating the V-groove cathode make it an attractive alternative to the brush cathode for many applications. (auth) (STAR)

44444 SHOCK IONIZATION KINETICS OF PURE NITROGEN. Bentley, S. B. (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 12: 1939-41(Sept. 1969).

The ionization-rate limiting processes behind strong shock waves in pure nitrogen are studied by variation of the coefficients for the kinetic processes in the fluid-dynamic equations representing a one-dimensional shock wave. (auth)

Stability

Refer also to abstracts 44385 and 44468.

44445 (AD-688887) OVERSTABLE MODES DUE TO RESISTIVITY GRADIENT. Herrnegger, Franz (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Mar. 31, 1969. Contract F61052-67-C-0014. 24p. (UNICP-SR-59; AFOSR-69-1401-TR). CFSTI.

It is shown that, in an incompressible plasma sheet with resistivity gradients perpendicular to the main magnetic field, overstable modes can exist. A criterion for overstability is given. This criterion shows that the existence of overstability depends on the curvature of the curve of the resistivity. An approximate solution of the stability equation is given. In the general case of an inhomogeneous plasma embedded in a constant gravitational field, the region of neutral stability depends essentially on the resistivity gradient except if the plasma is homogeneous. (auth) (USGRDR)

44446 (AEC-tr-7071) HYDRODYNAMIC THEORY OF STABILITY OF LAMINAR FLUX OF DENSE PLASMA. Baikov, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17760. 21p. Dep. CFSTI.

An abstract of the original Russian report appears in NSA 23: 12873. (L.M.T.)

44447 (CONF-680113-(Vol.5), pp 85-106) STUDY OF THE ANISOTROPIC INSTABILITY OF PLASMA HEATED IN AN ADIABATIC TRAP BY MEANS OF ELECTRON-CYCLOTRON RESONANCE. Alikaev, V. V.; Glagolov, V. M.; Morozov, S. A. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

The experiments were carried out with a device described in an earlier paper, heating the plasma electrons in a cylindrical vacuum resonator, in which a stationary-adiabatic-trap-like, magnetic field was created. The electrons were heated in the pressure range from 1.5 to 6×10^{-4} mm of Hg, with the chamber containing a gas such as hydrogen, nitrogen, or argon. The instabilities developed in the system were studied by means of a spectrum analyzer, determining the probability of an instability at a given frequency. The instability is accompanied by the ejection of energetic particles along and across the lines of force of the magnetic field; this may be observed by means of the x radiation resulting from the slowing down of fast electrons in the tungsten target. The concentration of the hot components amounted to 2×10^{10} cm^{-3}; the concentration of the cold components was estimated from the ionization of the neutral gas of the hot component. The electron temperature did not exceed 30 keV. The inhomogeneity of the plasma and the magnetic field and the correlation between longitudinal and transverse waves were not taken into account. (TTT)

44448 (CONF-680113-(Vol.5), pp 113-201) STABILIZATION OF THE PLASMA BY HIGH-FREQUENCY ELECTROMAGNETIC FIELDS. Demirkhanov, R. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). (In Russian).

Methods proposed for suppressing hydrodynamic and kinetic instabilities in plasma by means of hf electromagnetic waves are reviewed. Experiments were carried out to suppress specifically the flute instability and the drift-type microinstability generated by such fields, studying the interaction of the hf field with the skin layer. The plasma pinch effect was investigated in the presence of a hf, helical quadrupole field in the plasma, in order to be able to prevent hydrodynamic and kinetic instabilities in thermonuclear devices. The stabilizing mechanisms were examined on the basis of several models, in which (1) the effect of stabilizing inhomogeneous magnetic fields acting on the particles from the side of the hf field was examined; (2) only the stabilizing effect of a logitudinal homogeneous hf electric field was considered, and (3) only the magnetic component of the hf field penetrating into the plasma was taken into account. The experimental results are promising for the application of hf fields, although the studies are only at their initial stage. (TTT)

44449 (CONF-680113-(Vol.5), pp 203-27) POTENTIAL USE OF VERY-HIGH-FREQUENCY FIELDS FOR STABILIZING THE CONVECTIVE INSTABILITY OF PLASMA. Glagolev, V. M.; Khromov, I. N.; Cheverev, N. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). (In Russian).

Experimental studies were carried out to determine the interaction of vhf fields with $\omega \sim 2 \times 10^{10}$ sec^{-1} of a volume resonator, with a plasma having $n \cong 10^{13}$ to 10^{14} cm^{-3} in a constant electric field. A paramagnetic current flowed on the surface of the plasma under the influence of the vhf pressure. The observed effect of the increased static magnetic field within the plasma agreed with the calculated value At $\omega_b/\omega = 0.5$, and an electron paramagnetic resonance was observed, resulting in a sudden increase of the plasma pressure. It was attempted to make use of this experimentally observed paramagnetic effect to stabilize the convective instability of plasma in various systems. It was concluded that the hf stabilization may be used for suppressing the convective instability of hot plasma in both open and closed magnetic traps. (TTT)

44450 STABILITY OF A STREAMING COMPRESSIBLE PLASMA SURROUNDED BY A NONCONDUCTING GAS. Raghavachar, M. R. (Indian Inst. of Science, Bangalore). Publ. Astron. Soc. Jap., 20: 346-55(Dec. 1968).

The stability of a streaming compressible plasma surrounded by a nonconducting gas in the presence of aligned magnetic fields is investigated. It was found that the effect of compressibility introduces an infinite number of growing and decaying modes giving rise to instability of the system. Moreover, in the limit of small wave number, one derives the stability criterion obtained by Michael, Zabusky and Jain for the incompressible case. (NSA of Japan)

44451 STATIONARY EQUILIBRIUM OF A TWO-DIMENSIONAL PLASMA IN A MAGNETIC FIELD. Yoshikawa, S.; Barrault, M. R. (Princeton Univ., N. J.). Phys. Fluids, 12: 1858-64 (Sept. 1969).

Equilibrium of plasmas in a uniform magnetic field is considered with E × B plasma motion perpendicular to the magnetic field and gravitational field (simulating magnetic field curvature). It is concluded that the equilibrium of moving plasmas in the absence of current parallel to the magnetic field is limited to a very small class of configurations even without gravitational field. With the motion of plasma included, the plasma equilibrium other than the plasma pressure, p = p(U) where U is the gravitational potential, can be constructed. Finally, the implication of the plasma motion for the increase of the resistive diffusion is considered. It is shown that under a large-Larmor-radius configuration, the resistive diffusion could be increased over the classical rate by an amount proportional to the square of the length of a device over the plasma radius. (auth)

44452 INFLUENCE OF THE SELF-INDUCED MAGNETIC FIELD ON THE STABILITY OF A PLASMA COLUMN IN A LONGITUDINAL MAGNETIC FIELD. Paranjape, B. V. (Univ. of Alberta, Edmonton); Seale, D.; Ng, K. C.; Johnson, Roy R. Phys. Fluids, 12: 1865-70(Sept. 1969).

The Kadomtstev and Nedospasov theory of the helical instability of a positive column is extended to include force arising from the self-induced magnetic field, which pulls the plasma to the center. The effect is considered only to lowest order. It is predicted that an unstable positive column at critical longitudinal magnetic field will become stable if the electric current is increased. Modifications in frequency and wavelength associated with the increased current are derived. (auth)

44453 DRIFT WAVE INSTABILITY IN GENERAL MAGNETIC FIELD CONFIGURATIONS. Siambis, John G. (Carnegie-Mellon Univ., Pittsburgh). Phys. Fluids, 12: 1871-7(Sept. 1969).

A method is presented for the investigation of the propagation and stability properties of drift waves driven by a density gradient and other low-frequency electrostatic waves in realistic magnetic field configurations confining a low-pressure plasma in static equilibrium. At the outset the method utilizes the guiding-center motion and associated invariants of the charged particle in order to obtain the perturbation in the charge density in terms of the electrostatic potential associated with the wave. For linear stellarator- and levitron-type fields of infinite axial extent, unstable, nonseverely localized, normal modes are found in contrast to the severely localized modes of planar slab geometry with simulated shear. The imposition of boundary conditions on the linear stellarator-type field to simulate a closed toroidal field yields standing waves along the magnetic field line and high m numbers (short wavelength) for the azimuthal field transverse to the magnetic field line. The rapid helical winding, around the hard core, of the field lines of the linear levitron-type field of infinite axial extent constrains the maximum wavelength along the field line to a single helical turn, a constraint which leads to high m numbers for the azimuthal field. In both the case of the linear stellarator field with identified ends and the case of the linear levitron field of infinite axial extent, the stabilizing effect of shear is manifested by short transverse wavelengths for the drift wave leading to reduced anomalous diffusion. (auth)

44454 FLUTE FLUCTUATIONS IN A LINEAR QUADRUPOLE DEVICE. Rusbridge, M. G.; Meservey, E. B. (Princeton Univ., N. J.). Phys. Fluids, 12: 1917-25(Sept. 1969).

Flute fluctuations have been studied in an afterglow discharge in a linear quadrupole device. They are observed outside the critical surface; inside, their amplitude is unobservably small. The results support the stability criterion including adiabatic effects. The phase velocity and growth rate of the fluctuations outside the critical surface have been measured and compared with a simple linear theory; significant differences from the theory are found, some of which can be explained qualitatively by a more elaborate linear theory. It is not clear, however, whether this theory would account for the differences or whether nonlinear effects are also important. The radial transport of plasma due to these fluctuations is estimated and compared with the observed loss rate, but it is shown that some other mechanisms must exist for transporting plasma from the stable region across the critical surface. (auth)

44455 INFLUENCE OF STOCHASTIC RF FIELD ON PLASMA STABILITY. Krlin, L. (Inst. of Plasma Physics, Prague). Phys. Lett., 29A: 599(Aug. 11, 1969).

The influence of the stochastic heating in perpendicular velocities on the stability of electrostatic plasma oscillations in a magnetic field is discussed. (auth)

44456 A CLASS OF PLASMA EQUILIBRIA IN LINEAR MULTIPOLE MAGNETIC FIELDS. Tanaka, Masatoshi; Mori, Shigeru (Japan Atomic Energy Research Inst., Tokai). Kakuyugo Kenkyu, 23: 173-82(July 1969). (In Japanese).

A formulation is described to obtain a class of MHD plasma equilibria in linear filamentary multipole magnetic fields. Variations of magnetic lines of force due to the presence of plasma are calculated by a perturbation technique up to the linear terms in plasma pressure. The distributions of plasma pressure are assumed to have a peak on the separatrix of the vacuum magnetic field. (NSA of Japan)

44457 STABILIZATION OF A DRIFT-DISSIPATIVE INSTABILITY. Pyatak, A. I. (Technical Physics Inst., Kharkov). Ukr. Fiz. Zh., 14: 524-7(Mar. 1969). (In Russian).

In a number of studies it has been shown that it is possible to attain partial stabilization of some instabilities by preliminary modulation of a charged-particle beam. The modulation destroys the phasing of the particle necessary for development of the instability. The effect of modulation on the expansion of a drift instability is investigated. The equations of motions are written for the electrons along the field, and for the ions transverse to the magnetic field. A layered structure is created in the plasma by a perturbed electric field. Mathematical analysis shows that partial stabilization of a drift-dissipative instability can be obtained in a plasma with a layered structure. (TTT)

Thermonuclear Processes

44458 (AD-686103) MECHANISM AND DYNAMICS OF COAXIAL PLASMA ACCELERATION. Interim Technical Report No. 2. Bostick, W. H.; Grunberger, L.; Prior, W. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Mar. 1969. 10p. (SIT-P-234; AFOSR-69-984-TR). CFSTI.

It is shown by 5-nsec image converter photography and neutron scintillators that the neutrons coming from the plasma focus at the end of a plasma coaxial accelerator are produced by the mutual annihilation of ortho plasma vortices and not by the m = o, MHD instabilities or by the symmetric compressions which were previously credited with leading roles in neutron production in all z pinches. (auth) (USGRDR)

44459 (CTC-16) PEPSI: PLASMA ELECTRON PROFILES, SYMMETRIC INTEGRALS. A PROGRAM THAT MODELS THE MAGNETIC FIELD CONFIGURATION IN A THERMONUCLEAR PLASMA. DeLozier, Randall C.; Park, James E.; Guest, G. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Sept. 4, 1969. Contract W-7405-eng-26. 121p. Dep. CFSTI.

A FORTRAN-coded program that models the self-consistent magnetic field configuration in a dense, energetic plasma is described. The code was developed to study hot electron distributions such as those found in a strongly diamagnetic plasma and allows for a wide range of assumed electron distributions. The program enables the user to study the effect on the equilibrium plasma distributions of different plasma pressures and spatial configurations. Instructions for using the code and a sample problem with input and output sheets are included. (auth)

44460 (N-69-29236) PRESENT SITUATION AND FUTURE PROSPECTS OF CONTROLLED NUCLEAR FUSION. Lehnert, Bo. Translated from a Swedish Report. 29p. (NASA-TT-F-12237). CFSTI.

Power production based on controlled fusion of deuterium and tritium nuclei, in order to meet the demands for a strongly enhanced energy consumption, is presented. For the controlled release of fusion energy in a reactor, a fully ionized gas of heavy hydrogen has to be kept at a temperature of the order of millions of degrees Kelvin during times of the order of seconds. A self-sustained fusion reaction is, therefore, only possible if the ionized gas (the plasma) is prevented in a very efficient way from getting into contact with the walls of the reaction chamber. The most promising method in this respect is to use a magnetic field in the

shape of a magnetic bottle which confines the plasma. In addition to this, methods are required for heating the plasma to the necessary temperature range, as well as a number of technical arrangements for the generation of the magnetic field and the development of the reaction chamber. (auth) (STAR)

44461 INJECTION OF RELATIVISTIC ELECTRONS INTO ASTRON. Weiss, Paul B. (Univ. of California, Livermore). pp 221-33 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

Data are given showing the electron velocities and distribution in Astron. Current diagrams are also given. (M.O.W.)

44462 METHOD FOR MAKING BASEBALL SEAM MAGNETIC COILS. Henning, Carl D. (to United States Atomic Energy Commission). U. S. Patent 3,465,431. Sept. 9, 1969.

This patent relates to a method for making an electromagnetic coil, approximating a baseball seam in configuration, free of self-induced bending moments. The coil is fabricated of pliable wire in roughly the desired configuration. Thereupon, at each of the two loci of closest approach of opposite loops of the "baseball-seam" coil, a respective rigid bar is attached to restrain their moving apart, and the coil is pulsed with a large electrical current to cause permanent deformation of the wire into precisely a bending-moment-free configuration. Such a coil is of interest for restraining and compressing plasma toward facilitating a controlled thermonuclear reaction. (AEC)

Wave Phenomena

Refer also to abstracts 44289 and 44453.

44463 (AD-685889) COLLECTIVE EXCITATIONS OF A TWO-COMPONENT PLASMA IN A MAGNETIC FIELD; STABILITY CONDITIONS AND RELATED PHENOMENA. Final Report, March 31, 1966-March 31, 1969. Houghton, Anthony (Brown Univ., Providence, R. I.). Mar. 1969. Contract DA-31-124-ARO(D)-445. 7p. CFSTI.

Areas covered under this research included: propagation of electromagnetic and acoustic waves in one- and two-component plasmas; the attenuation of longitudinal sound propagating at arbitrary angles to a dc magnetic field in metals; magnetic interaction between conduction electrons in metals; and the superconducting state. (auth) (USGRDR)

44464 (AD-688885) RESEARCH ON INTERACTION OF PLASMA STREAMS WITH MAGNETIC FIELDS. Final Report. Sellen, J. M. Jr. (TRW Systems, Redondo Beach, Calif.). Apr. 1969. Contract AF49(638)-1538. 75p. (AFOSR-69-1226-TR). CFSTI.

Low-energy synthesized Cs^+ plasma streams have been generated. Plasma densities of 10^{10} ion/cm^3 have been generated at ion streaming energies of 1 eV. Longitudinal velocity spreads of approximately 10^4 cm/sec are inferred from transverse velocity measurements and conservation of energy. Low energy streaming Cs^+ plasmas have been directed into stationary thermal Cs^+ plasmas. Longitudinal wave growth was not observed. Ion Landau damping of ion-acoustic waves is greatly reduced by the presence of the streaming plasmas. Beam-related azimuthal drift waves were observed in a Q machine confining field for this bi-plasma system. Plasma behavior was observed for streaming plasmas interacting with transverse and longitudinal magnetic fields. Transport and cutoff of the plasma stream by transverse fields is consistent with Fried-Ossakow. Confinement of radially diverging plasma streams by longitudinal B fields is exponential in B for 0 to ~100 gauss. Saturation in confinement is observed for B > ~100 gauss. Turbulence in plasma stream permits enhanced electron diffusion and limits effectiveness of B-field confinement. (USGRDR)

44465 (CONF-680113-(Vol.5), pp 253-69) INTERACTION OF MAGNETIC WAVES WITH PLASMA. Gorbunov, L. M. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). (In Russian).

Theoretical studies were carried out on the interaction of high-amplitude electromagnetic waves with plasma, examining first the small perturbations in a plasma without collisions, within a strong homogeneous hf electric field. This was followed by a study of the parametric oscillations of waves in an inhomogeneous plasma, placed in an inhomogeneous high-frequency electric field. The self-consistent, stationary distribution of the plasma in the hf field and the motion of the plasma under the pressure of such a field were also investigated. The linear theory of small perturbations of a homogeneous plasma within a homogeneous hf field is at a much higher level of development than the study of the properties of plasma in an inhomogeneous strong vhf field, specifically for stability, dynamics, and equilibrium states, etc. (TTT)

44466 INTERACTION OF LANGMUIR PLASMONS. Liperovskii, V. A.; Tsytovich, V. N. (Inst. of Cosmic Studies, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 823-9(1969). (In Russian).

The known expression for the probability of the four-plasmon interaction of waves in a weakly turbulent plasma is refined. Some qualitative consequences of dynamics of four-plasmon interactions are considered. (auth)

44467 ELECTROMAGNETIC WAVE SCATTERING FROM A FINITE-VOLUME TURBULENT PLASMA. Luzzi, Theodore E. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 342-7(May 1969).

General relations are developed for the classical scattering of plane electromagnetic waves in the first Born approximation from the turbulent fluctuations in the electron density of a weakly ionized, finite volume, arbitrarily shaped plasma. Former work applies only to the case of small correlation lengths. The transmitter for the incident and the receiver for the scattered radiation are assumed to be in the far field of the scattering plasma. Scattering relations for a one-dimensional plasma are presented in order to point out simply the differences between the large and small correlation length cases. The general scattering relations are specialized for a parallelpiped plasma with a Gaussian autocorrelation function. The resulting integral is solved on a computer. Results show that the scattered radiation can be much greater than that evaluated with the Booker-Gordon relation, when the correlation length is greater than the incident EM wavelength. The scattered radiation is equal to or less than the Booker-Gordon value when the EM wavelength is greater than the correlation length. (auth)

44468 INFLUENCE OF COLLISIONS ON THE ION-ACOUSTIC INSTABILITY IN A WEAKLY IONIZED PLASMA. Fujiwara, Masami; Raether, M.; Yamada, Masaaki (Nagoya Univ., Japan). J. Phys. Soc. Jap., 27: 758-63(Sept. 1969).

The influence of collisions on the onset and linear stage of the ion-acoustic instability in a dc-discharge in helium is studied experimentally. The threshold values of the drift velocity and frequency and the range of the unstable frequency spectrum are in good agreement with the values calculated from the dispersion relation based on the Vlasov equation with inclusion of ion-neutral collisions. The intensity of charged-particle density fluctuation was measured over 4 orders of magnitude, covering the range from thermal level to the fully developed instability. (auth)

44469 ION WAVE DAMPING IN A NONUNIFORM PLASMA. Takamura, Shuichi; Tanaka, Yuji; Okuda, Takayoshi (Nagoya Univ., Japan). J. Phys. Soc. Jap., 27: 737-46(Sept. 1969).

The propagation of ion waves externally excited by a gridded electrode in a nonuniform plasma is experimentally investigated. The nonuniformity of the zeroth-order drift velocity of ions plays a dominating role rather than that of the density in this plasma. The acceleration of ions along the direction of the propagation of ion waves in the presence of the ambipolar field causes an increase in its phase velocity and also an attenuation of the density perturbation. The attenuation is attributed partly to the loss of the wave momentum due to nonuniformity and partly to an ionization. These new phenomena are examined quantitatively on the basis of the fluid equations using the WKB approximation and a rigorous numerical computation. (auth)

44470 EXPERIMENTAL INVESTIGATION OF THE NORMAL MODES IN A WARM CYLINDRICAL PLASMA. Ben-Yosef, N. (Hebrew Univ., Jerusalem). J. Appl. Phys., 40: 3680-6(Aug. 1969).

Experimental observations of the normal modes in a cylindrical plasma without external excitation is presented. The experimental results compare favorably with theory. Measurement of the high-frequency electromagnetic field outside of the plasma and its spectrum lead to a method of measuring the electrostatic oscillations spectrum in a plasma without perturbing it in any way. Exact measurement of the emission profile at the plasma frequency can give information about the mean thermal speed of the electrons without any assumption about their distribution function. (auth)

44471 INFLUENCE OF AN EXTERNAL ELECTROMAGNETIC FIELD ON OSCILLATIONS IN A POSITIVE GLOW DISCHARGE COLUMN. Andreev, M. P.; Buchakliev, Z. Compt. Rend. Acad. Bulg. Sci., 22: 29-32(1969). (In Russian).

The influence of an external 30- to 200-kHz electromagnetic field on oscillations in a positive glow discharge column was studied. The studies were limited to the gas pressure and current not inducing self-excitation of plasma oscillations, diffusion waves, or propagating waves. The relationship between the amplitude of induced plasma oscillations and applied field frequency was studied at various amplitudes, current discharge power, and

gas pressures. An attempt was made at measuring some parameters of plasma waves and obtaining their dispersion curve. (R.V.J.)

44472 PROPAGATION IN A TWO-STREAM MAGNETOPLASMA. Chawla, B. R. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Unz, Hillel. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 384-5(May 1969).

The wave equation for an electromagnetic wave in a two-stream magnetoplasma is derived, and the dispersion equations are found in particular cases. (auth)

44473 ON THE REFLECTION COEFFICIENT OF A PLASMA PROFILE OF EXPONENTIALLY TAPERED ELECTRON DENSITY AND FIXED COLLISION FREQUENCY. Harrison, Charles W. Jr.; Jones, Rondall E. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation, AP-17: 395-6(May 1969).

The reflection coefficient (ratio of reflected to incident electric fields) is found at an arbitrary point within a plasma profile of exponentially tapered electron density and fixed collision frequency. To facilitate the analytical solution of the problem it is found advantageous to terminate the profile in a perfectly conducting plate. This artifice has little physical significance if the plate is positioned in the region of reflection, where the electromagnetic field is negligible. But there is some indeterminancy in locating this region. In this analysis the plate is located at the level of electron density, where the magnitude of the complex relative dielectric constant passes through a minimum, or where the real dielectric constant goes through zero since in the region of these points the electromagnetic field is evanescent. Reflection factors for both plate locations are computed and compared. Evidently, when the plate is positioned at the lower electron density, the magnitude of the reflection coefficient is larger so that an upper bound on the size of the coefficient is established. (auth)

44474 ENERGY AND MOMENTUM OF WAVES IN NON-UNIFORM PLASMAS. Buneman, Oscar (Stanford Univ., Calif.). Contract AF49(638)-1524. pp 41-99 of Relativistic Plasmas. Buneman, Oscar; Pardo, William B. (eds.). New York, W. A. Benjamin, Inc., 1968.

From Symposium on Relativistic Plasmas, Coral Gables, Fla. See CONF-680218.

A plasma wave, or wave packet, possesses certain permanent attributes which can be identified as its energy–momentum components, even when the unperturbed plasma is strongly nonuniform. The expressions for these attributes are quadratic in the amplitudes of the first-order field perturbations, the potential perturbations, and the distribution function perturbations, no reference to first-order perturbations having to be made. The wave energy is identifiable with the rf energy used in microwave and beam–plasma research. It is also identical with a certain quadratic invariant that has been employed successfully in stability studies. (auth)

44475 OPTICAL MEASUREMENTS OF EFFECTS OF COLLISIONAL DRIFT WAVES ON PLASMA DENSITY IN BARIUM PLASMAS. Johnson, L. C.; Chu, T. K.; Hendel, H.; Hinnov, E. (Princeton Univ., N. J.). Phys. Fluids, 12: 1949-51(Sept. 1969).

Effects of the collisional drift wave and of the presence of a Langmuir probe on plasma density in a Q-device barium plasma are investigated by means of independent measurements of local ion densities with the method of resonance fluorescence. (auth)

44476 EXPERIMENTAL INVESTIGATION OF THE ION–ION HYBRID RESONANCE. Baird III, A. W.; Swanson, D. G. (Univ. of Texas, Austin). Phys. Fluids, 12: 1878-85(Sept. 1969).

An experiment is described in which the ion–ion hybrid resonance is observed and studied. The theory of a cool, partially ionized plasma in a magnetic field is given, and dispersion characteristics of a wave launched in a bounded two-ion species plasma near the resonance are investigated. Computer results showing the behavior of the attenuation coefficient of the launched wave as a function of density, magnetic field, resistivity, density ratio of the ions, and frequency are given. The apparatus for generating a highly ionized pulsed plasma and for launching and detecting a wave in the plasma is described. The attenuation coefficient has been measured for a variety of plasma conditions; this data has been fitted to the predicted theory with generally good agreement using values of plasma density and temperature which are characteristic of the type of discharge used. (auth)

44477 RESISTIVE LOADING BY A FINITE PLASMA CYLINDER NEAR THE LOWER HYBRID RESONANCE. Skipping, C. R.; Oakes, M. E.; Schlueter, H. (Univ. of Texas, Austin). Phys. Fluids, 12: 1886-93(Sept. 1969).

A theoretical study is carried out for the resistive loading of a finite wave-generating coil concentric with a uniform plasma immersed in an axial magnetic field and bounded by conducting end plates. The solutions are used to make a numerical and analytic study of the influence of coupling resonances on resistive loading near the lower hybrid resonance. For proper values of the plasma parameters the coupling resonances are strong and completely mask the hybrid resonance. The highest-order Fourier components of the wave may contribute substantially to the loading resistance, affecting both its magnitude and the location of the resonance minima. (auth)

44478 SURFACE WAVES IN HOT PLASMAS. Guernsey, Ralph L. (Univ. of Maryland, College Park). Phys. Fluids, 12: 1852-7(Sept. 1969).

The solution of the initial-value problem for a semi-infinite Vlasov plasma, with no applied fields, is given. In the long-wavelength limit, in addition to the usual plasma waves, terms corresponding to surface plasma waves, for which the dispersion relation is given, are found. (auth)

44479 SELF-EXCITED ION-ACOUSTIC WAVES IN A RADIO-FREQUENCY PLASMA. Lisitano, G. (Institut fuer Plasmaphysik, Garching, Ger.); Bernabei, S.; Sindoni, E. Phys. Lett., 29A: 613-14(Aug. 11, 1969).

The frequency dependence of self-excited ion–acoustic waves on ion mass, electron temperature, and collisions was studied in a rf plasma. The results are in excellent agreement with theoretical provisions. (auth)

44480 REFLECTION OF AN ELECTROMAGNETIC WAVE FROM A MAGNETICALLY ACTIVE PLASMA AT INCLINED INCIDENCE. Onishchenko, I. N. (Technical Physics Inst., Kharkov). Ukr. Fiz. Zh., 14: 512-14(Mar. 1969). (In Russian).

Assume a partially limited plasma with a sharp boundary in a magnetic field H parallel to the plasma boundary. The coordinate system is chosen so that the z axis is directed along the magnetic field, and the plasma is in the region $x > 0$. With inclined incidence of the electromagnetic wave, the wave vector lies in the xz plane, and the electric field is perpendicular to the plane of incidence. Reflection and absorption coefficients during diffusion reflection of plasma particles from the boundary are calculated for the case of large values of the tensor component of the dielectric penetrability. The initial set of Maxwell equations and the kinetic equation are solved by the Fourier method. Expressions are found for the reflection coefficients of two reflected waves polarized in the plane of incidence and perpendicular to it. A relatively simple expression is also obtained for the absorption coefficient. The results may be useful in experiments on high-frequency diagnostics and plasma heating. (TTT)

44481 PLASMA IMPEDANCE AND ITS EQUIVALENT CIRCUIT. Wada, Ikuko (Tokyo Univ.). Electron. Commun. Jap. (Engl. Transl.), 51: 89-92(July 1968).

A circuit analysis of wave propagation in a plasma is attempted to represent the wave behavior in terms of equivalent transmission lines and various impedances. No new phenomena have been discovered by this technique, but this theoretical study points out the usefulness of the circuit theory for future studies of plasmas. The approach also provides a convenient method of analysis when a plasma is used as a circuit element. The behavior of the plasma under a dc electric field also may be represented by an equivalent circuit by including negative resistances. The variation of the equivalent capacitance with various physical parameters is useful for an analysis of the parametric behavior of the plasma. Discussion is limited to plane waves propagating normal to and parallel to the external magnetic field, but the method of analysis may be generalized for application to more generalized boundary conditions. This technique may be applied in the analysis of reflections normal to the direction of propagation in a plasma with finite transverse dimensions and in the analysis of wave propagation in any arbitrary direction relative to the external magnetic field. (BBB)

44482 MODE THEORY OF WAVEGUIDE FILLED WITH WARM UNIAXIAL PLASMA. Tuan, Hang-sheng (State Univ. of New York, Stony Brook). IEEE (Inst. Elec. Electron. Eng.) Trans. Microwave Theor. Tech., MTT-17: 134-7(Mar. 1969).

With the warm plasma model as a generalization, power transfer inside a waveguide is possible not only in connection with electromagnetic fields but also with pressure and velocity fields. In general, it is difficult to obtain simple physical pictures from complicated formal solutions for waveguides filled with anisotropic warm plasma. A relatively simple case was studied as a first step toward this generalization; i.e., a study was made of the characteristics of propagating modes in guides filled with plasma which is assumed to possess uniaxial anisotropy with a nonvanishing elec-

tron pressure gradient. This model is called uniaxial warm plasma in contrast to the uniaxial cold plasma model, which has been used extensively in investigating electromagnetic radiation problems. Uniaxial anisotropic warm plasma arises when the externally applied magnetic field is very strong either for fixed operating frequency and electron density or for low operating frequency at a fixed static magnetic field strength. Basic equations of the plasma are derived. The validity of the plasma model and its physical significance are discussed. It has been found that TE modes are not affected by the presence of plasma. However, TM modes do have significant changes. Under the condition specified, each TM mode splits into 2 submodes. One has a low-frequency cutoff and the other propagates for all frequencies. The nature of power transfer in these modes was also investigated. A comparison of the effects as well as the physical significance of the changes due to cold and warm uniaxial plasma models are discussed. (BBB)

44483 ON THE PROPERTIES OF WARM-PLASMA-FILLED RECTANGULAR WAVEGUIDE WITH STRONG TRANSVERSE MAGNETIC FIELD. Tuan, Hang-sheng (State Univ. of New York, Stony Brook). IEEE (Inst. Elec. Electron. Eng.) Trans. Microwave Theory Tech., MTT-17: 164-5(Mar. 1969).

Characteristics of electromagnetic wave propagation in a rectangular waveguide filled with uniaxial anisotropic warm plasma are investigated. The static magnetic field is assumed to be transverse to the guide axis. This case is generally called TMG (transversely magnetized plasma waveguide). It is found that electric and magnetic field components in the transverse direction along the static magnetic field are conveniently used as potential functions which satisfy separate wave equations. This is because ordinary hybrid modes are propagating. Thus, propagating waves are easily classified into TE and TM modes with respect to the direction of static magnetic field. An extension to include the temperature effect in a uniaxial plasma-filled waveguide is given. (BBB)

44484 COMPARISON OF THE EXCITATION ENERGY OF PLASMA OSCILLATIONS WITH THE AVERAGE KINETIC ELECTRON ENERGY IN THE ELECTRON PLASMA. Schoenebeck, H. (Univ., Berlin). Z. Angew. Phys., 27: 238-40(July 14, 1969). (In German).

The excitation energy of plasma oscillations is compared with the average kinetic energy per electron. This comparison is extended over values of both energies, which depend on temperature. The energy distribution of the electrons is treated by Fermi-Dirac statistics. If the temperature exceeds a "limiting temperature," which depends on electron density, the ratio of excitation energy and average kinetic energy becomes smaller than unity. In this region thermal excitation of plasma oscillations may occur. (auth)

44485 DISPERSION RELATIONSHIPS OF PLASMA PENETRATED BY BEAMS. Gheorghe, Viorica (Institutul de Fizica, Bucharest). Stud. Cercet. Fiz., 21: 145-66(1969). (In Rumanian).

The following topics are discussed: (1) dispersion equation of plasma waves, (2) dispersion curve of longitudinal waves; the electron wave, and (3) dispersion relationship of longitudinal oscillations in plasma penetrated by beams. (M.O.W.)

Shielding

Refer also to abstracts 44756 and 44765.

44486 (AD-687722) RRA-62: A SPECIAL VERSION OF THE COHORT SO1 CODE. Price, J. H. (Radiation Research Associates, Inc., Fort Worth, Tex.). Feb. 1967. Contract DA-49-146-XZ-479. 49p. (RRA-T-72). CFSTI.

COHORT is a family of Monte Carlo codes written in FORTRAN-IV to solve a wide variety of radiation heating and transport problems. Modifications were made to SO1, the primary source generator code of the COHORT package, to make the code more versatile and to reduce the amount of external data handling required in applying COHORT to problems involving cylindrical volumes exposed to specified radiation environments. As a result of these modifications, the code accepts incident radiation energy and angle distributions as direct input and computes internally the probability distributions to be sampled in generating the starting parameters for individual radiation particles. This special version of SO1, designated RRA-62, relates to the remaining codes in the COHORT package in exactly the same manner as the original SO1. (auth) (USGRDR)

44487 (AD-688929) EXPERIMENTAL DETERMINATION OF THE GAMMA-RAY SHIELDING CHARACTERISTICS OF A RIBBED SLAB. Report on Nuclear Radiation Shielding Studies. Green, D. W.; Preiss, K.; Chilton, S. P.; Chilton, A. B. (Illinois Univ., Urbana). Apr. 1969. Contract N00228-66-C-0311. 72p. (NRSS-9; USNRDL-TRC-69-1). CFSTI.

Experiments were carried out to measure the shielding effectiveness of concrete slabs, both ribbed and equivalent smeared configurations, for broad parallel beams of essentially monoenergetic radiation. The broad-beam source configuration was simulated by means of a movable source of cobalt-60 radiation collimated to a thin beam, and by use of a line detector. Angles of incidence of 0, 45, and 60° were investigated. Results are compared with previous Monte Carlo calculations and shown to be consistent with them, provided certain factors, such as the angular spread of the collimated beam, are taken into account. (auth) (USGRDR)

44488 LOW-ENERGY X-RAY SHIELDING WITH COMMON MATERIALS. O'Riordan, M. C.; Catt, B. R. (Radiological Protection Service, Sutton, Eng.). Health Phys., 17: 516-18 (Sept. 1969).

There is a paucity of information on the x-ray protective values of common materials at low kilovoltages. Such data are frequently useful, for example in dealing with x-ray analytical equipment, electron microscopes, television tubes, and high-voltage rectifiers, where the structural materials or surrounding components may serve to reduce radiation dose rates significantly. Broad-beam transmission data were obtained for aluminum, mild steel, sheet glass, Perspex (Lucite), and wood in the 10- to 50-kV range. Results are tabulated. (auth) (UK)

44489 SMALL PERTURBATIONS OF THE GAMMA RADIATION FIELD BEHIND A BARRIER. Vorob'ev, V. A.; Tarasov, G. P. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 66-70(1968). (In Russian).

In the small perturbation approach the variational functions for the radiation field behind a barrier, dependent on the presence in the barrier of local heterogeneity of the type of cavity, are considered. A variational formula is given, which is convenient for the use of the method of statistical tests for quantitative estimates. (tr-auth)

44490 CHANDRASEKHAR'S X- AND Y-FUNCTIONS FOR ISOTROPIC SCATTERING IN THICK SLABS. Clancy, B. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. J. Phys., 22: 317-26(June 1969).

Approximate forms are developed for the X and Y functions of isotropic scattering of Chandrasekhar in terms of the well-tabulated H function. The approximations that are asymptotically correct for slabs of large thickness are compared with available tabulated values. (auth) (Australia)

44491 GAMMA-RAYS AND NEUTRONS STREAMING THROUGH AIR FILLED CYLINDRICAL DUCTS IN WATER WITH OFF-SET ALIGNMENT. Yamaki, Hideo; Fukushima, Yutaka; Uchida, Shunsuke (Hitachi Ltd., Japan). J. Nucl. Sci. Technol., 6: 424-32(Aug. 1969).

Radiation streaming effects through an off-set duct was studied by systematically changing four geometrical factors in a parametric survey by calculation and experiment. The calculations were based on the ray-analysis method. The four geometric parameters of the duct were (a) wall radius, (b) total length, (c) location of the off-set point, and (d) distance of off-set. The distribution of the leakage dose rate was measured in the direction across the duct outlet, parallel to that of off-set. The calculations took into account such effects as those of neutron capture γ rays, dose buildup for γ rays transmitted through shield, and photoneutrons in the water. Satisfactory agreement was obtained between calculation and experiment for γ rays. For neutrons the agreement was not good, and the discrepancy is attributed to roughness in the approximations adopted for the calculations and to insufficient precision afforded by the method of measurement. Nevertheless, the calculations still provide results useful for obtaining a rough outline estimate of neutron streaming and which should serve for reference in shield design. (auth)

44492 A V^9 IMPORTANCE FUNCTION FOR THE MONTE CARLO CALCULATION OF THE DEEP PENETRATION OF GAMMA RAYS. Armstrong, T. W.; Stevens, P. N. (Univ. of Tennessee, Knoxville). J. Nucl. Energy, 23: 331-59(July 1969).

The successful application of the Monte Carlo method to problems involving the deep penetration of uncharged radiation requires the specification of an importance function which will identify and utilize those regions of phase space which contribute most heavily to the answer of interest. An importance function based on the first (or V^9) term of the series representation of the value (or adjoint) function is formulated and evaluated. For the case of 1 MeV gamma rays incident normally on thick homogeneous slabs of lead and water, it was demonstrated that this V^9 importance sampling scheme, which employs spatial, polar angle, and azimuthal biasing, provides considerable improvement over the conventional exponential transform method. For the

same computation times, the variance of the dose buildup at 21 mfp was reduced by factors of about 125 and 50 for lead and water, respectively. For the particular source-geometry configuration investigated it was determined that approximately equal reductions in variance were obtained by spatial and polar angle biasing with essentially no improvement provided by the azimuthal angle biasing. (auth) (UK)

Solid-State Physics

Refer also to abstract 43613.

Radiation Effects

Refer also to abstracts 43366, 43645, 43994, 44158, and 44159.

44493 (AD-682373) THE INTERACTION OF LOW-ENERGY ATMOSPHERIC IONS WITH CONTROLLED SURFACES. Final Report, April 1, 1966–April 1, 1968. Prince, R. H.; French, J. B. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Dec. 1968. Contract AF33(615)-3855. 130p. (UTIAS-133; AFFDL-TR-68-148). CFSTI.

The ejection of electrons associated with the Auger neutralization of N_2^+, H_2^+ and N^+ ions at the (100) face of a tungsten single crystal and a polycrystalline molybdenum surface was studied for the first time in the energy range 10 to 30 eV under controlled surface conditions. The dependence of the electron yields and energy distributions on ion energy was investigated in detail for the above ion-surface combinations. The combination of ultrahigh vacuum techniques to lengthen the time required to reach adsorption equilibrium after flashing, and special guarding and analog data-reduction techniques to reduce instrumentation time response, permitted the study of transient adsorption effects as well as the more usual equilibrium studies. Surface contamination was inferred using the measurement of work function, which is sensitive to surface adsorption levels. The fact that the electron yields for diatomic ions was considerably lower than those for the inert-gas ions treated well by Hagstrum's theory led Propst and Luscher to propose that the neutralized ion may be vibrationally excited as a consequence of the interaction. A quantitative calculation was performed in this low-energy regime for which kinetic broadening effects may be safely neglected. The simplified theoretical treatment provides good agreement with Propst and Luscher's data for 50 eV N_2 (+) ions on polycrystalline tungsten, using a value of the escape parameter f (the anisotropy of excited metal electrons) taken from Hagstrum's work. A slightly larger anisotropy permits good agreement with the present data for the (100) face of a tungsten single crystal. (auth) (USGRDR)

44494 (N-69-30360) INFRARED ABSORPTION DUE TO IMPURITIES AND RADIATION DAMAGE IN SEMICONDUCTORS. Final Report. Gilmer, T. E. Jr. (Virginia Univ., Charlottesville). Mar. 1969. 9p. (NASA-CR-101691; SAPR-8). CFSTI.

Optical measurements on donor and acceptor states of lithium and lithium–oxygen complexes in silicon, and on radiation effects in silicon semiconductors are reported. Lithium-doped silicon crystals pulled from quartz crucibles have oxygen concentrations of the order of 10^{17} to 10^{18} cm^{-3} and higher, whereas float-zone-obtained crystals exhibit no evidence of lithium–oxide spectra; it is assumed that the oxygen either diffuses or is reduced to such a small concentration that it is spectrally difficult to determine. Electron paramagnetic resonance spectra of low-temperature irradiated silicon samples confirm the mobility of interstitials in silicon under cryogenic conditions. Attempts to induce an optical absorption attributable to the lithium-damage-center complex in silicon were unsuccessful. (auth) (STAR)

44495 (TID-25126) ELECTRON SPIN RESONANCE STUDIES OF IRRADIATION INDUCED VALENCE CHANGES AND GROUND STATE SPLITTINGS OF RARE EARTH IONS IN CUBIC AND AXIAL CRYSTAL FIELDS. Reynolds, Robert Ware (Vanderbilt Univ., Nashville, Tenn.). June 1969. 119p. Dep. CFSTI. Thesis.

The ground-state splitting of rare earth and actinide ions with total angular momentum $J = 7/2$ was determined in cubic, tetragonal, and trigonal crystalline electric fields. In a cubic field with eightfold coordination ($SrCl_2$), the eightfold degenerate free ion ground state of Yb^{3+} and Tm^{2+} is split, leaving a doubly degenerate Γ_7 ground state, while in a sixfold coordinated cubic site (CaO), the ground state of these ions are doubly degenerate Γ_6 states. These results are in agreement with the predictions of the point charge model of the crystal field. The ground state wavefunctions of Yb^{3+} in tetragonal sites of CaO have a form only slightly different from those of Yb^{3+} in cubic sites indicating a weak axial distortion. The Yb g-values for the tetragonal site show that the distortion is due to a negative charge compensation site. The ground state of Gd^{3+} ($4f^7$, $^8S_{7/2}$) in tetragonal sites of $ZrSiO_4$, $HfSiO_4$, and $ThSiO_4$ was split into four doublets with the $|S = 7/2, M_s = \pm 7/2\rangle$ doublet lowest. Due to the weak interaction of the S-state ion with the crystal field, it was possible to measure this splitting as a function of temperature. The symmetry of the ESR spectra in these hosts determined that the local crystal structure of each was similar. The Gd^{3+} actinide analog Cm^{3+} ($5f^7$, $^8S_{7/2}$) in the same crystal fields had a much larger splitting but with the same $|S = 7/2, M_s = \pm 1/2\rangle$ doublet lowest so that no ESR signals could be observed. The ground state of divalent europium (isoelectronic with Gd^{3+}) in a trigonal field of ThO_2 was also split into four doublets, whose order was inverted with respect to the silicates, so that the $|S = 7/2, M_s = \pm 1/2\rangle$ doublet was lowest. The Eu^{2+} splitting was much larger than that found before for $4f^7$ ions, indicating a larger departure from a pure $^8S_{7/2}$ ground state. The production of Tm^{2+} was successful in Tm-doped $SrCl_2$ and CaO, the latter case being the first instance in which a divalent rare earth (other than Eu^{2+}) has been observed in a sixfold coordinated host. The Tm^{2+} in CaO was only stable below room temperature. Tm^{2+} could not be produced in the eightfold coordinated cubic crystals CeO_2 and ThO_2; however, Eu^{3+} was reduced to Eu^{2+} in ThO_2. Eu^{2+} was not produced in CeO_2 under identical irradiation procedures. In contrast to other cases of irradiation produced divalency, the Eu^{2+} occupied sites with trigonal rather than cubic symmetry and represents the first instance in which a divalent rare earth ion was found to occupy a tetravalent site. Hyperfine structure was measured for the odd isotopes of the above ions. For the non S-state ions Yb^{3+} and Tm^{2+}, the hyperfine splitting constants were used to compute values of $\langle 1/r^3 \rangle$. The hyperfine spectrum of Eu^{2+} was complicated by the large quadrupole and nuclear Zeeman interactions. (auth)

44496 300°K ANNEALING OF ELECTRON DAMAGE IN LITHIUM-DOPED SILICON. Stannard, J. E. (Naval Research Lab., Washington, D. C.). Contract NAS-7-100. Appl. Phys. Lett., 15: 93-5(Aug. 1, 1969).

Electron irradiation of lithium-doped silicon at 77°K causes an increase in acceptor concentration as measured by Hall effect. Subsequent annealing at 300°K causes this acceptor concentration to decrease along with an associated decrease in the concentrations of both isolated lithium and lithium paired with oxygen. The decrease in lithium content substantially exceeds the decrease in acceptor concentration. (auth)

44497 EFFECTS OF IRRADIATION OF 100-keV ELECTRONS ON ALKALI HALIDE CRYSTALS: THE POINT DEFECT COAGULATES IN NaCl AND KCl IRRADIATED AT ROOM TEMPERATURE. Izumi, Kunihidi (Kyoto Univ.). J. Phys. Soc. Jap., 26: 1451-61(June 1969).

Thin films of KCl and NaCl single crystals prepared by chemical polishing were examined by an electron microscope. During the observation, the thin films were damaged by an electron beam used for the image formation. As a result of electron irradiation at room temperature, plate-shaped defects parallel to one of the {100} planes and elongated in one of the ⟨100⟩ directions were formed in both kinds of crystals. Their maximum dimensions were about 1 μ in the long axis, 1000 to 3000 Å in the short axis, and ~100 Å in thickness. It is supposed that these plates correspond to the small alkali metal colloids, which were considered to be the origin of X-band absorption in the optical measurement, because the behavior of the plates during heat treatment between room temperature and 300°C showed good agreement with that of the colloids. (auth)

44498 IMPURITY CONDUCTION IN Sb-DOPED GERMANIUM IN THE PRESENCE OF A LOW CONCENTRATION OF GAMMA-RAY DEFECTS. Swenson, G. (Chalmers Univ. of Tech., Gothenburg, Sweden). Ark. Fys., 39: 171-91(1969).

The effect of γ irradiation at both 77 and 300°K on impurity conducting Sb-doped germanium was investigated by means of resistivity and Hall-effect measurements down to 2°K. The compensation in the material was varied between 0.04 and 3.5% by the irradiation. The corresponding changes in the low-temperature resistivity (in the impurity conduction range) were compared to the theoretical compensation dependence according to Mott's trapping model and the Miller–Abrahams model. A strong deviation from both theories was found when the compensation was less than 1%. After irradiation at 77°K, the annealing behavior was examined between 77 and 400°K. A strong recovery (approximately 50%) of the low-temperature resistivity was found below an annealing temperature of 200°K. (Sweden)

44499 ANTIRESONANCE PHENOMENA IN THE ABSORPTION SPECTRA OF RARE-EARTH IONS IN X-IRRADIATED CaF_2. Taylor, M. J. (Royal Radar Establishment, Worcestershire, Eng.). Phys. Rev. Lett., 23: 405-7(Aug. 25, 1969).

Some absorption lines of rare-earth ions in calcium fluoride were found to be considerably affected by irradiation with x rays. These narrow lines, which appeared superimposed on a broad

background of color-center absorption, were in some cases over 100 times stronger after irradiation and had strongly asymmetric line shapes, often resulting in an antiresonance dip. It is proposed that these effects are caused by interaction of the rare-earth ion and a neighboring color center. (auth)

44500 TAXONOMY OF F-AGGREGATE CENTERS IN NaF. Chandra, Ashoka; Holcomb, D. F. (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys., 51: 1509-23(Aug. 15, 1969).

Results of a study of broad and narrow optical absorption bands of F-aggregate color centers in NaF are given in terms of correspondence between optical absorption band and defect model. Comparison is given to previous work. New results or results which modify previous conclusions are reported for F_2^+, F_3^+, M', M, and N centers, as well as for an impurity center which gives rise to a prominent optical absorption band at 312 mμ (300°K). It is proposed that this center consists of an oxygen-impurity–F-center complex. A number of identifications were made possible through use of OH^- and O^{2-} dopings, which favor centers with net positive and net negative charges, respectively. (auth)

44501 THEORY OF X-RAY AND THERMAL-NEUTRON SCATTERING BY REAL CRYSTALS. Krivoglaz, Mikhail A. New York, Plenum Press, 1969. 422p.

Translation of Teoriya Rasseyaniya Rentgenovskikh Luchei i Teplovykh Neitronov Real'nymi Kristallami by Simon C. Moss.

Topics discussed are: fluctuations of composition and order parameters in undistorted solid solutions; fluctuation waves of static displacements in nonideal crystals; effects of long-range forces on fluctuations in crystals; general theory of x-ray and thermal-neutron elastic scattering by nonideal crystals; diffuse scattering of x rays and neutrons at fluctuation inhomogeneities of crystals; weakening of the line intensities on the x-ray diffraction picture; scattering of x rays by severely distorted crystals; scattering of x rays at thermal vibrations of the atoms in crystals; inelastic scattering of neutrons at vibrations of ideal harmonic crystals; and energy distribution of the single-phonon scattering of neutrons and determination of the relaxation characteristics of the phonons. (D.H.M.)

44502 THERMAL CYCLING OF NEUTRON IRRADIATED β_1 BRASS. Hummel, R. E.; Kestenbach, H.-J. (Univ. of Florida, Gainesville). Phys. Status Solidi, 34: K67-9(July 1, 1969).

Experiments were conducted to elucidate whether a large number of low-temperature cycles would restore the martensitic temperature (M_s) of an irradiated sample to the pre-irradiation value. β-brass samples were repeatedly cooled to liquid nitrogen temperature and heated back to room temperature at a rate of approximately 30°C per min. The resistivity–temperature curves were measured at a cooling rate of 1°C per min in order to determine the M_s temperature. Results show that 120 low-temperature cycles are not enough to restore the pre-irradiation M_s temperature; the increase of M_s does not start significantly before 5 cycles; the largest rate of increase of M_s occurs between some 10 and 90 cycles; and the increase of M_s is larger for the irradiated and annealed sample than for the specimen that was only irradiated. (D.H.M.)

44503 INFLUENCE OF CHANNELLING IN CONVENTIONAL ^{3}He ACTIVATION ANALYSIS. Ricci, Enzo (Oak Ridge National Lab., Tenn.). Analyst, 94: 435-40(June 1969).

Channeling results when energetic charged particles enter a crystal with small angles relative to its lattice rows or planes; the ions suffer small-angle collisions with lattice atoms that tend to channel their paths inside the crystal. The channeling effect offers advantages and drawbacks to charged-particle activation analysis. In order to investigate whether this effect should be expected in routine analytical bombardments, a germanium single-crystal ingot was cut into numerous slices, perpendicular to its [1,1,1] axis, each of these slices was mounted on a 0.2° precision goniometer, and bombarded at different angles with 7.8 ± 0.2-MeV ^{3}He ions. As activation analysis is based on counting of induced radioactivity, this was preferred to measurement of prompt nuclear reaction products. As the channeling critical angle was 0.56 ± 0.01°, the bombardment angles used (beam with respect to [1,1,1] axis of sample) were −1.0, −0.8, −0.6, −0.4, −0.2, 0, 0.2, 0.4, 0.6, 0.8 1.0, 4.0, 4.4, 4.8, 5.0, 5.2, 5.6, and 6.0°. The products of the germanium bombardment, viz., ^{71}As, ^{72}As, ^{74}As, ^{76}As, and ^{73}Se, were identified and the individual radioactivities, as well as their sum, were plotted against irradiation angle. Results indicated that the induced radioactivity was independent of angle, i.e., channeling effect was not observed. Because of the conditions chosen for these experiments it can be concluded that the channeling effect cannot influence most conventional charged-particle activation analyses. (auth) (UK)

44504 THERMAL REEMISSION OF NOBLE GASES BURIED IN POLYCRYSTALLINE NICKEL AND IN (100) SINGLE CRYSTAL NICKEL. Moen, Allen LeRoy. Pullman, Wash., Washington State Univ., 1968. 70p.

Thesis.

The trapping and thermal reemission of 100- to 500-eV argon, krypton, and helium ions in polycrystalline nickel was studied. The trapping probability of helium was found to be 0.055, 0.22, and 0.39 for 100, 250, and 500 eV, respectively; this was from polycrystalline nickel with at most a monolayer of residual gases formed during ion burial. Peaks in the thermal reemission spectra of argon, krypton, and helium from polycrystalline nickel were found, with a surface condition different from that obtained during trapping measurements. The surface condition used for most of the reemission spectra reported here was obtained by prolonged heating (10 minutes or more) at 1213°K and possibly included strongly chemisorbed carbon or oxygen. According to first-order desorption theory, the peaks in the reemission spectra of argon had activation energies of 1.18, 1.35, 1.53, and 1.74 eV. The activation energies for reemission of krypton were 1.18, 1.36, 1.50, and 1.71 eV. The activation energies for reemission of helium were 1.09, 1.20, 1.47, 1.85, 3.10, and 3.42 eV. Possible release mechanisms are interstitial migration, 1.03 to 1.09 eV; vacancy formation, 1.35 eV; vacancy migration, 1.55 eV; surface diffusion, 1.68 eV; nickel self diffusion, 2.65 to 2.83 eV; and helium bubble diffusion. Postbombardment by krypton rearranged buried argon among the various sites available and prebombardment with argon enhanced subsequent helium trapping. Peaks in the thermal reemission spectra of 100- to 2400-eV argon from the clean (100) face of nickel were found. They had activation energies of 1.05, 1.31, 1.74, 2.21, and 2.78 eV. The activation energies for the reemission of 100- to 1400-eV helium were 1.04, 1.33, 1.71, 2.18, 3.0, and 3.4 eV. Possible release mechanisms are interstitial migration, 1.03 to 1.09 eV, vacancy formation, 1.35 eV, surface diffusion, 1.68 eV, nickel self-diffusion, 2.65 to 2.83 eV, and helium bubble diffusion. Prebombardment with argon again enhanced subsequent helium trapping. Postbombardment with argon emptied the helium so rapidly that it appears that a thermal spike mechanism provided local heating to reemit the helium. (Disser. Abstr.)

44505 ION-ELECTRON EMISSION: FORMATION AND ANNEALING OF RADIATION DEFECTS DURING BOMBARDMENT OF GERMANIUM BY XENON IONS. Abroyan, I. A.; Belyakov, V. S.; Tutov, A. I. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2965-7(June 1969).

Translated from Fiz. Tverd. Tela, 10: 3726-8(Dec. 1968).

Typical relations are shown between the coefficient α (which characterized the ion–electron emission and, in this case, represents the ratio of the collector current and the primary current with potentials on the collector and the screen of +150 V and +100 V, respectively) and the energy of the singly charged xenon ions normally incident on the (111) face of a germanium single crystal. In the energy range $3 < E < 15$ keV the coefficient α increases linearly with increasing energy of the xenon ions, reaching 22 to 23% at 15 keV. It follows that during bombardment by ions there is significant potential ejection. The dependence of α on the angle of incidence of the primary beam was also investigated. Experiments are described for which the ion-current density (j) was varied from 1 to 8 μA/cm^2. The two characteristic temperatures T_a and T_k were found (T_a is the amorphization temperature, i.e., the temperature at which the structure disappears in $\alpha(\varphi)$, and T_k is the temperature at which the function $\alpha(\varphi)$ begins to smooth out). The relation $\ln j(1/T_k)$ was found experimentally to be represented by a straight line, with an activation energy ΔE of 1.8 ± 0.3 eV. (D.H.M.)

44506 EPR SPECTRUM AND SPIN–LATTICE RELAXATION IN IRRADIATED POLYETHYLENE. Dzhabakhishvili, L. Ya.; Ketiladze, G. D.; Sanadze, T. I. (Tiflis State Univ., USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 2954-6(June 1969).

Translated from Fiz. Tverd. Tela, 10: 3515-17(Dec. 1968).

Results of a study of the EPR spectrum of irradiated polyethylene established that, at low temperatures, the spectrum of the R centers contain 11 almost equidistant hfs lines with a binomial relationship of the intensities. It is suggested that the spectrum belongs to an exchange-bound pair of radicals of B type, stabilized in neighboring polymer chains. For small radiation doses in a reactor (mixed γ–n irradiation) the EPR spectrum consisted of 6 broad almost equidistant lines with an intensity ratio 1:5:10, belonging to B centers. As radiation dose was increased, the sample being kept at room temperature, the spectrum gradually changed its shape. In the intermediate case, the form of the spectrum consisted of a superposition of the spectra of B and R centers. A study of the dependence of the spin–lattice relaxation time on the radiation dose showed that the relaxation probability first increases linearly and then "saturates." (D.H.M.)

44507 THE FLUCTUATIONS AND SCATTERING PROCESSES OF SLOW NEUTRONS AND ELECTROMAGNETIC WAVES

IN FERROMAGNETS HAVING SMALL MAGNETIC ANISOTROPY. Akhiezer, I. A.; Belozorov, D. P. (Kharkov State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2835-40(June 1969). Translated from Fiz. Tverd. Tela, 10: 3571-8(Dec. 1968).

The fluctuations and scattering processes of slow neutrons and electromagnetic waves are studied in ferromagnetic crystals having small magnetic anisotropy. The correlators of fluctuating quantities that characterize such a crystal are determined, allowing for the coupling of elastic waves and oscillations of the magnetic moment. It is shown that as the critical point is approached, at which the character of the ferromagnet's magnetic anisotropy changes, the correlators increase sharply. This is because an instability in the crystal spin system arises at this point. As a consequence, as the critical point is neared, the differential cross sections for scattering of slow neutrons and electromagnetic waves also grow sharply. (auth)

44508 PHOTOCONDUCTIVITY STUDY OF DIVACANCY FORMATION IN NEUTRON-IRRADIATED Si. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett., 15: 61-4(July 15, 1969).

Photoconductivity measurements between 1.2 and 5 μ were used to study the annealing characteristics of defects in p-type silicon following neutron irradiation at 82°K. In particular, the 3.9-μ photoconductivity peak previously associated with the presence of divacancies in irradiated silicon was investigated. The magnitude of the 3.9-μ peak is found to be small after neutron irradiation at 82°K, but it increases markedly during subsequent annealing between 175 and 375°K. The annealing growth of the 3.9-μ (divacancy) peak between 275 and 375°K is similar to vacancy-oxygen center growth previously observed following neutron irradiation ~225°K. The divacancy growth is attributed to vacancy liberation from neutron-produced defect clusters in accord with the previous interpretation of vacancy-oxygen center growth. The annealing lots of the 3.9-μ peak between 375 and 550°K is correlated with the annealing of divacancies as measured by optical absorption after room-temperature neutron irradiation. (auth)

44509 STEPWISE ACCUMULATION OF ELECTRON CENTERS IN IONIC CRYSTALS UNDER THE EFFECT OF IRRADIATION. Vaisburd, D. I.; Melik-Gaikazyan, I. Ya.; Roshchina, L. I. (Tomsk Polytechnical Inst., USSR). Teor. Eksp. Khim., 5: 141-3(Jan.-Feb. 1969). (In Russian).

Crystals of NaCl and KCl containing Pb^{2+} and Mn^{2+} as electron-acceptor impurities were irradiated at room temperatures by protons or x rays. The optical absorption spectra were measured in a direction parallel to the irradiation. It was found that the dependence of the concentration of electron centers (F and M) as a function of irradiation dose was stepwise. The stepwise dependence of the F-center concentration on the irradiation time indicated that there are a number of micromechanisms for creating anion vacancies and F centers in the irradiated crystal. An expression is given for the radiation accumulation of F centers from one source with the concentration of potential vacancies, the conversion of a potential vacancy into a real one per unit time, the capture of a vacancy electron with conversion to an F center, and the radiation annealing of F centers being taken into account. Since a number of independent sources exist in the crystal, the resulting dependence of the accumulation of F centers as a function of irradiation dose can be stepwise. (TTT)

44510 RADIOACTIVE DECAY AND ASSOCIATED ELECTRICAL CHANGES IN FAST-NEUTRON-IRRADIATED CdS. Johnson, R. T. Jr.; Kenna, B. T. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 182: 851-62(June 15, 1969).

Changes in resistivity (or conductivity) with time after fast-neutron irradiation have been correlated with the measured decay of radioactivity from CdS. After accounting for effects associated with thermal annealing, the results have shown that induced conductivity results from the β decays of ^{115}Cd (2.3-day half-life) and ^{32}P (14.3-day half-life). Ionization resulting from the absorption of β radiation produces the induced conductivity. Absorption of γ radiation from the ^{115}Cd decay was insignificant. The electron free lifetime τ_n was determined from the induced conductivity, the mobility, the β-decay rate, the radiation-ionization energy, and the average energy absorbed per β particle. Results from 14-MeV neutron irradiations (this study) and reactor fast-neutron irradiations (previous study) have shown that τ_n is dependent on the distance of the electron quasi-Fermi level E_{Fn}, below the edge of the conduction band. When $E_{Fn} \gtrsim 0.37$ eV ($\rho \gtrsim 2 \times 10^4$ Ω cm), τ_n is of the order of tens of msec. However, for $E_{Fn} \lesssim 0.37$ eV, τ_n is larger by a factor of ~10^3. The limiting position of E_{Fn} in fast-neutron-irradiated CdS is ≈0.37 eV, and depends on the induced defects as well as ionization. The large increase in τ_n with decreasing E_{Fn} probably arises because the process determining the occupancy of sensitizing centers changes from thermal-equilibrium kinetics to recombination kinetics. These centers are probably associated with fast-neutron-induced defects (or defect clusters). These results, in conjunction with a study of the changes in resistivity with fluence and the characteristics of thermal annealing, have shown that 14-MeV neutrons and reactor fast neutrons produce the same kinds of defects in CdS. Some unique features of these experiments were that resistivities were obtained in the range 10^1–10^6 Ω cm by radiation doping, and that τ_n was determined by self-ionization resulting from the β decay of radioisotopes. Also discussed are resistivity inhomogeneities in CdS, and γ-induced conductivity and photoconductivity experiments in fast-neutron-irradiated CdS. (auth)

44511 IRRADIATION DAMAGE IN SrF_2 AND BaF_2. Tzalmona, A.; Pershan, P. S. (Harvard Univ., Cambridge, Mass.). Contract N00014-67-A-0298-0006. Phys. Rev., 182: 906-13 (June 15, 1969).

The thermoluminescence of rare-earth-doped SrF_2 and BaF_2 irradiated with x rays at 77°K is interpreted in terms of the appearance and disappearance of three paramagnetic hole centers. The V_K center is similar to one previously reported in CaF_2. The V_K center appears to be a V_K center trapped near a monovalent impurity ion. The third center, designated as V_H, is associated with an interstitial fluorine. Separate thermal activation of translational and rotational motion has been observed for the V_K center in BaF_2. (auth)

44512 DEFECT CLUSTER CENTERS IN MgO. Chen, Y.; Williams, R. T.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). Phys. Rev., 182: 960-4(June 15, 1969).

A study of the production and annealing of defect cluster centers in MgO single crystals was undertaken. A comparison of the annealing of single negative-ion vacancies in neutron-irradiated, electron-irradiated, and Mg-additively colored samples is made. The results indicate that isolated negative-ion vacancies are not mobile below 900°C, and the annealing of these defects at lower temperatures in irradiated crystals is due to interstitial migration. The broad absorption bands at 352, 573, and 975 nm and the zero-phonon lines observed in neutron-irradiated crystals, previously proposed as due to F-aggregate centers, are not observed in electron-irradiated and additively colored samples even after annealing. Therefore, there is some uncertainty whether these lines and/or bands are due to F-aggregate centers. (auth)

44513 MEASUREMENTS OF THE ELECTRON-IRRADIATION DAMAGE RATES IN MAGNESIUM. Faust, W. E.; O'Neal, T. N.; Chaplin, R. L. (Clemson Univ., S. C.). Phys. Rev., 183: 609-10(July 15, 1969).

Experimental values of damage rates have been obtained for polycrystalline magnesium for electron irradiations in the energy range 0.125 to 0.40 MeV. A value of 10 ± 0.5 eV is determined for the threshold energy of atomic displacement. Experimental damage rates are compared to theoretical calculations of the cross section for atomic displacements. (auth)

44514 ELECTRICAL STUDIES OF ELECTRON-IRRADIATED LITHIUM-CONTAINING n-TYPE SILICON. Brucker, George J. (RCA, Inc., Princeton, N. J.). Contracts JPL 952249; NAS5-10239. Phys. Rev., 183: 712-24(July 15, 1969).

Hall-coefficient and resistivity measurements have been used to investigate the crystal growth and irradiation-temperature dependence of the introduction rate and room-temperature annealing of carrier-removal defects in lithium-doped silicon. Initial resistivity of the quartz-crucible silicon was 30 Ω cm and of the float-zone silicon was ≥1500Ω cm. The silicon was doped with lithium to a density of 2×10^{16} cm^{-3}. Irradiations were carried out with 1-MeV electrons at bombardment temperatures ranging from 79 to 280°K. Specimens were annealed to 200°K, thereby separating intrinsic and impurity defects. Introduction rates of carrier-removal defects were exponentially dependent on the reciprocal of temperature for both types of crystal, but the slopes and limiting temperature values differed. The slope of the carrier-removal rate versus reciprocal temperature curve is 0.055 eV in crucible silicon and 0.09 eV in zone-refined silicon. The temperature dependence was not consistent with a simple charge-state-dependent probability of interstitial-vacancy dissociation and impurity-vacancy trapping. Carrier concentrations measured at or near room temperature were increased in zone silicon, but were decreased in crucible silicon by isothermal annealing at room temperature. Crucible-silicon samples annealed to 373°K for 10 min exhibited complete recovery of mobility. Complete recovery of mobility in float-zone-refined silicon took place in an annealing time ≤17 hr at room temperature. The time constant of the annealing kinetics at room temperature is consistent with the observation that the lithium-diffusion constant in oxygen-rich silicon is smaller than that in oxygen-lean silicon. The mechanism of room-temperature annealing is attributed to neutralization of carrier-removal defects by lithium interaction in crucible

silicon, and by both lithium interaction and defect dissociation in zone-refined silicon. Results suggest that radiation produces a lithium–oxygen-vacancy complex in quartz-crucible-grown silicon, and a lithium-vacancy complex in float-zone-refined silicon. The LiO-V defect is tightly bound compared to the oxygen-free Li-V defect. Measurements of carrier density as a function of reciprocal temperature located defect-energy levels near $E_c - (0.18\ eV)$ and $E_c - (0.13\ eV)$, in irradiated-crucible silicon. The former defect level is the A center, and the latter is the reverse annealing center, which is formed at a temperature of 250°K. A defect level located near $E_c - (0.08\ eV)$ formed after crucible-silicon samples were annealed at room temperature and lithium interacted with radiation defects. (auth)

44515 LUMINESCENCE IN INTRINSIC AND ANNEALED ELECTRON-IRRADIATED GaAs:Cd. Arnold, George W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 183: 777-83(July 15, 1969).

The lasing transition in boat-grown cadmium-doped GaAs is similar to that previously found in GaAs:Zn. In cadmium-doped GaAs, the three excited states of this transition (C′, B′, and A′) lie at energies of 1.484, 1.486, and 1.507 eV, respectively. In addition, there is a broad-band emission peak centered at 1.37 eV. All of these peaks move to lower energies with decreasing excitation intensity. 1.5-MeV electron irradiation causes exponential decreases in the broad-band and near-band-edge intensities with increasing electron fluence for fluences greater than 10^{16} e/cm^2. Isochronal annealing of the irradiated material in the temperature range 50–190°C causes increases in the emission centered about 1.37 eV, but the emission is modified and appears as two peaks (Cd 0, and Cd 1) at 1.369 and 1.337 eV. The temperature dependence of the intensity of the peaks indicates that Cd 1 is a phonon replica of Cd 0. The development of the structure is interpreted as occurring when Ga vacancies migrate and form localized modes that weaken the coupling of the Cd 0 defect to the lattice. Diminution of intensity and loss of structure are observed in the temperature range 190–240°C and result from a decrease in the number of centers giving rise to localized modes. The killer center which degrades the luminescence is believed to be the As vacancy which anneals out at about 240°C. The energy shifts of the lasing transition and of the broad-band emission are interpreted to indicate that both bands are the emission envelopes of unresolved donor-acceptor pair transitions. The lasing transition arises from the recombination of holes localized at neutral Cd acceptors, with electrons localized at donors, possibly Si; whereas the broad-band emission is due to pair annihilation involving the same donor and Cd in a different charge state. (auth)

44516 EFFECT OF ALPHA IRRADIATION ON THE X-RAY DIFFRACTION PROFILES OF SILICON SINGLE CRYSTALS. Burgeat, J. (CNET, Seine, France); Colella, R. J. Appl. Phys., 40: 3505-9(Aug. 1969).

A series of perfect single crystals of silicon were irradiated with alpha particles from ^{210}Po to a maximum dose of 20.1×10^{15} α/cm^2. The convoluted profiles obtained by means of a double-crystal spectrometer in the (n, −n) arrangement, with a perfect unirradiated crystal on the first axis, exhibit a secondary peak on the low-angle side with half-width and peak intensity comparable to that of the main peak in most cases. The main peak does not seem to be much influenced by irradiation except for a slight depression and broadening. The dynamical theory as developed by Taupin for imperfect crystals has been applied to these results by assuming that the only effect of irradiation is to introduce a uniform change in the lattice constant of the crystal which is function only of depth normal to the crystal surface. The convoluted reflectivity of such an imperfect crystal is computed at the reflecting surface in the symmetrical Bragg case by using a profile for the damage as computed from the simple theory of collision based on Rutherford scattering and on the hard sphere model. A satisfactory agreement is found, on a qualitative basis, between computed and experimental profiles. The fact that the calculated profiles, within the limitations of the approximations involved, can reproduce the essential features of the experimental ones suggests that some coherence is preserved between the diffracted waves. The damaged region of the crystal, having a varying lattice parameter, gives rise to a secondary peak but exerts a negligible absorption effect on the main peak, which originates from the bulk. (auth)

44517 COMPARISON OF THE RECOVERY OF DAMAGE IN W AND Mo AFTER NEUTRON IRRADIATION. Keys, L. K.; Moteff, J. (General Electric Co., Cincinnati). J. Appl. Phys., 40: 3866-8(Aug. 1969).

Recrystallized W and Mo were irradiated at ~70°C with a fast neutron fluence of 9.8×10^{19} n/cm^2. The recovery of the radiation damage was measured by the isochronal resistivity technique up to 1900°C and the recovery plotted as the first derivative with respect to temperature versus homologous temperature T/T_m (T_m = melting temperature, °K). Two dominant recovery stages are seen at ~0.15 T_m and 0.31 T_m. The low-temperature Stage III recovery begins well above the irradiation temperature for W, while for Mo it begins at ≤0°C, indicating that the Stage III defect is more mobile in Mo. The results are consistent with interstitial migration in Stage III at ~0.15 T_m and vacancy migration in Stage IV at ~0.31 T_m in W and Mo. (D.L.C.)

44518 THREE NEW ELECTRON SPIN RESONANCE CENTERS IN ELECTRON-IRRADIATED SILICON. Horiye, H.; Wikner, E. G. (Gulf General Atomic Inc., San Diego, Calif.). J. Appl. Phys., 40: 3879-80(Aug. 1969).

Three new ESR centers were found in P-doped Si after irradiation with 30-MeV electrons at 300°K; they have not previously been reported. ESR measurements were made at 20 and 50°K, and the characteristics of the ESR spectra (shape, width, g-values, etc.) are described. The effects of the Fermi level on the introduction of the centers are discussed, and estimates of the center concentrations are given. (D.L.C.)

44519 EFFECT OF ^{60}Co GAMMA-RAY IRRADIATION ON THE PHASE TRANSITIONS IN $NaNO_2$. Gesi, Kazuo (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap., 27: 629-32(Sept. 1969).

Single crystals of $NaNO_2$ were irradiated with ^{60}Co gamma rays of 1 to 6×10^8 R at room temperature, and then the dielectric constant ϵ_{22} was measured in the vicinity of the transition temperatures. Both the ferroelectric-to-sinusoidal transition point (the Curie point) and the sinusoidal-to-paraelectric transition point (the Néel point) monotonically decrease with gamma irradiation. The ratio of the initial decreasing rate of the Curie point to that of the Néel point is 1.21. The sinusoidal phase widens with irradiation up to 2.5×10^8 R, and then it narrows with more irradiations. The transitions become sluggish with irradiation dose more than 2.5×10^8 R. (auth)

44520 RADIATION-INDUCED CONDUCTIVITY OF SEMICONDUCTORS ON BOMBARDING WITH PARTICLES OF AVERAGE ENERGY. Abroyan, I. A.; Titov, A. I.; Tsekhnovicher, L. A. (Leningrad Polytechnical Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 792-7(May 1969). (In Russian).

Studies of the radiation-induced conductivity of semiconductors, caused by the excitation of current carriers on bombardment with ions and electrons, were carried out with attention being given to the incidence angle, and also in parallel, to the secondary electron emission. Plots of the ratios of the radiation-induced conductivity and of the secondary electron emission as a function of incidence angle show a nonmonotonic character for the irradiation of germanium by potassium ions, tritons, and electrons. The radiation-induced conductivity coefficient is a maximum, when the ion–electron emission coefficient passes through a minimum. Since the radiation conductivity under these conditions did not depend on the penetration depth of the primary particles, this behavior indicates that the total number of excited electrons is also a maximum at this orientation of the primary beam. It has been found that long ionic bombardments lead to a decrease in radiation-induced conductivity, which is explained by the accumulation of radiation-induced defects (recombination centers) in the surface layer of the semiconductor. (TTT)

44521 DISTRIBUTION OF ATOMS SLOWED DOWN ON IRRADIATING SINGLE CRYSTALS WITH A BEAM OF FAST ATOMIC PARTICLES. Titov, V. V. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 785-91(May 1969). (In Russian).

On movement of a fast particle in the linear channel of a monocrystal, the energy losses due to elastic collisions with the lattice atoms are comparable to the losses due to inelastic collisions. An expression is obtained for the range of a particle having an energy E_0. The values of constants C_1 and C_0 in this equation are calculated for bombardment of Si, W, and Al by Xe and Kr. The constant C_0C_1 is more sensitive to the degree of transparency of the channel. Large atoms such as xenon lose most of their energy by elastic collision, while smaller incident atoms such as phosphorous lose their energy by inelastic collision even at low energies of 8 keV. For large values of the initial energy, the range of the particle is practically determined by the distance that it travels in the channel. An expression is obtained for the total number of particles striking the channel directly. As a first approximation, it is assumed that the number of particles incident on the linear channel is inversely proportional to the particle energy E. The distribution of assimilated atoms along the depth of the monocrystal can be computed. It is found that if the irradiation dose is not too high, the experimental values lie satisfactorily on the calculated curves on plotting the distribution of slowed-down atoms as a function of crystal depth. (TTT)

44522 FORMATION OF F CENTERS AND ELECTRON RECOMBINATION LUMINESCENCE IN ALKALI METAL HALIDE CRYSTALS ACTIVATED WITH Eu^{2+}. Pvakhnenko, P. S.; Parfianovich, I. A.; Shuraleva, E. I. (Irkutsk State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 844-7(May 1969). (In Russian).

It has been shown theoretically and experimentally that the processes of coloration and light emission are competitive in pure crystals and in KI. Experiments were carried out at temperatures of 93 to 343°K on KI–Eu, KCl–Eu, and KBr–Eu crystals containing two concentrations of activator (0.03 and 0.005 mol % Eu). For all temperatures a sharp increase in x-ray luminescence was observed, and then, a drop. Only at the low temperatures of 93 to 153°K did the burnout in brightness proceed more slowly, since the hole processes were frozen in this case. The growth in F centers has two stages for temperatures above 153°K. A linear stage appears after two hours of x-ray treatment at 193 to 233°K, and after three hours treatment above 293°K. The greater the accumulation of F centers, the greater the relative fall in brightness of the x-ray luminescence proceeds fastest in the region of the first, nonlinear stage of coloration. (TTT)

44523 STUDY OF THE OXIDATION OF TUNGSTEN BY THE METHOD OF SECONDARY ION–ION EMISSION. Rybalko, V. F.; Kolot, V. Ya.; Fogel, Ya. M. (Inst. of Tech. Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 836-9(May 1969). (In Russian).

The method of secondary ion–ion emission was used to study oxide films on niobium and beryllium. This method is quite suitable since it is not likely to change the state of the oxide film by rapid heating, such as is required with the mass spectrometric method of analysis. A tungsten strip 20 × 5 × 0.05 mm was bombarded with 4-keV argon ions while being held in an atmosphere of residual gas or of oxygen. The ions sputtered from the surface were analyzed on a mass spectroscope to determine the degree of oxidation. The intensity of ion current from a number of intermediate oxides was recorded as a function of the temperature of the tungsten strip. The oxides WO_2, WO_3, W_2O_3, W_2O_5, and W_2O were found on the tungsten surface. No noticeable evaporation of oxides from the tungsten surface was observed. (TTT)

44524 ANGULAR DISTRIBUTIONS OF ATOMS SPUTTERED FROM POLYCRYSTALLINE TARGETS BY IONS OF THE INERT GASES. Gurmin, B. M.; Ryzhov, Yu. A.; Shkarban, I. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 815-8(May 1969). (In Russian).

Certain analyses are carried out which show that angular distributions of sputtered atoms measured on rough, polycrystalline surfaces are determined by the form of the angular distribution on an ideal, smooth polycrystalline surface. Results of experimental measurements of angular distributions of sputtered Mo and W atoms on bombarding with inert gas ions having energies of 3 to 19 keV are presented at various angles of incidence of the ion beam on the target surface with a vacuum of 5×10^{-6} torr and an ion current density of 1.5 to 2.5 mA cm^{-2}. The asymmetry of the angular distribution is greater at lower energies of the bombarding ion. The depth of formation of the cascade of displaced ion increases with increasing ion energy. The preferred direction of exit of the nonsymmetrical component of sputtered atoms was an angle of 40 to 60° with the normal. The results indicate the substantial effect of the spacial structure of the cascade of displaced atoms on the character of the angular distributions of the sputtered particles. (TTT)

44525 LUMINESCENCE OF SILICON CARBIDE ON BOMBARDING WITH CHARGED PARTICLES OF MEDIUM ENERGY. Makarov, V. V.; Petrov, N. N.; Il'evskii, L. E. (Leningrad Polytechnical Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 809-14 (May 1969). (In Russian).

For powdered phosphors it had been shown that with equal energies of electrons and of alkali metal ions the electrons give off light greater by a factor of 20 to 1000. Hence, data on the luminescence from a semiconductor are used to estimate the number of excited electrons on irradiating single crystals of SiC with hydrogen, deuterium, or lithium ions having energies up to 20 keV. Photomultipliers were used to measure the emitted light. Deviations in the brightness ratio are due to differences in the maximum depth of generation of excited electrons and the character of the depth distribution during bombardment. Data are presented on the ranges of hydrogen, deuterium, and lithium ions, and on the average energy expended by these ions to form a single electron-hole pair. The number of generated pairs is plotted as a function of the initial energy of the bombarding particles. Evidence on the formation of defects by the primary particles can be obtained by investigating the changes in luminescent properties of samples as a result of ionic bombardment. (TTT)

44526 SPUTTERING OF InSb SINGLE CRYSTALS WITH 70-keV ARGON IONS. Kapusta, O. I.; Lebedev, S. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 806-8(May 1969). (In Russian).

A beam of 70-keV argon ions struck an InSb target perpendicularly to its surface. Sputtered material was collected on a plane collector of glass or aluminum placed at a distance of 25 mm from the target. Clear Wehner spots were obtained at target temperatures approaching the melting point. In directions close to the [111], [101], and [010] planes the sputtered material had a different density, and apparently a different chemical composition, as was especially noticeable on the glass collectors. Spectral analysis of the residues showed that the antimony content was significantly greater than the indium content, but to a different degree in various directions. The results agree well with the model developed by Harrison and Lehmann. (TTT)

44527 SCATTERING OF ALKALI-METAL IONS BY SURFACES OF POLY- AND SINGLE CRYSTALS. Arifov, V. A.; Khadzhimukhamedov, Kh. Kh.; Yunusov, A. I. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 801-5(May 1969). 1969). (In Russian).

Scattering of lithium, sodium, potassium, rubidium, and cesium ions by polycrystals of Ti, Ni, Zr, Mo, Ta, and W, and also by single crystals of Si, Mo, and W was carried out at ion energies of 0.2 to 4 keV. The scattering coefficient K_s increased with a decrease of initial energy E_0 and of the ionization potential V_i of the alkali metal. An increase in K_s in the region of low energies with increasing ion mass was observed both for single-crystal and for polycrystalline targets. Deviations were observed for targets having a low atomic weight and low density (Ti, Zr, and Ni). It is necessary to assume multiple collisions to explain the data satisfactorily. (TTT)

44528 ESR IN NEUTRON IRRADIATED $NaNO_2$ SINGLE CRYSTALS. Grecu, N. M. (Inst. of Atomic Physics, Cluj); Darabont, A. Rev. Roum. Phys., 14: 313-15(1969).

$NaNO_2$ single crystals were irradiated with ~10^{13} n/cm^2/sec and their ESR spectra examined. Three unequal lines were found in the spectrum and are assigned to two paramagnetic defects, the triplet defect being the NO_2 radical. The widths of the ESR lines are much broader than for gamma-irradiated samples, and this is attributed to inhomogeneities produced by the neutron irradiation. The kinetics of annealing of the irradiated crystal were also studied. (D.L.C.)

44529 ON THE SPATIAL DISTRIBUTION OF RECOIL ATOMS CREATED IN A COLLISION CASCADE IN CRYSTALLINE MATERIAL. Sanders, J. B. (FOM Instituut voor Atoom- en Molecuulphysica, Amsterdam). Physica, 41: 353-67(Feb. 28, 1969).

The dimensions of a collision cascade started by an energetic projectile in a solid are considered. An equation is derived for the spatial distribution function of low-energy recoil atoms created in the cascade. From this equation can be found a recurrence relation between quantities, which are linear combinations of the moments of different order of the components of the distance from the origin of the recoils created, respectively, in the initial direction of the projectile and perpendicular to this direction. This opens the possibility of calculating the density distribution as a function of the depth beneath the surface of a target where low-energy recoils are created by ion bombardment. (auth)

44530 EFFECT OF RADIATION TARGET DAMAGE ON THE ANGULAR REGULARITIES OF THE INTERACTION OF IONS WITH CRYSTAL ATOMS. Mashkova, E. S.; Molchanov, V. A. (Moscow Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 757-61 (May 1969). (In Russian).

The (110) and (111) edges of germanium and silicon crystals were irradiated with 15- to 30-keV ions of neon, argon, and krypton. According to estimates of cascade theory these heavy ions result in the displacement of thousands of lattice atoms. Effective annealing of the radiation damage can take place at relatively low temperatures with metals. The anisotropy coefficients from the ion–electron emission determined over a wide temperature interval showed a smooth increase with increasing angle of incidence of the heavy ion. A sharp jump in the anisotropy coefficient was observed over a narrow temperature interval between an ordered and disordered structure. The transition temperature depended on the type of bombarding heavy ion. The intensity of multiple-scattering peaks was increased at temperatures below the temperature of defect annealing. (TTT)

44531 EFFICIENT DOPING OF GaAs BY Se^+ ION IMPLANTATION. Foyt, A. G.; Donnelly, J. P.; Lindley, W. T. (Massachusetts Inst. of Tech, Lexington). Appl. Phys. Lett., 14: 372-4 (June 15, 1969).

Efficient doping of GaAs by ion implantation was obtained using Se^+ ions. For a Se^+ dose of 3×10^{12}/cm^2 implanted at 400 keV, a

peak carrier concentration of $2 \times 10^{17}/cm^3$ occurred at a depth of 750 Å, with a standard deviation of 500 Å. Integration of the excess carrier concentration caused by the implantation indicates that for this ion dose at least 50% of the implanted ions are electrically active. For larger doses the doping efficiency decreases, and the carrier concentration approaches a limiting value of approximately $10^{19}/cm^3$. The lowest observed sheet resistance for the implanted layer, about 250 Ω/square, occurred for a Se^+ dose of $2 \times 10^{14}/cm^2$. (auth)

44532 RADIATSIONNYE YAVLENIYA V DIELEKTRIKAKH I POLUPROVODNIKAKH. (Radiation Phenomena in Dielectrics and Semiconductors). Mikhaelyan, V. M. Tashkent, Izdatel'stvo Fan Uzbekskoi SSR, 1968. 80p.

Seventeen articles are included on nuclear radiation effects on optical, paramagnetic, and other properties of materials used in radioelectronics. Gamma and neutron irradiation effects on crystalline quartz and synthetic ruby are evaluated in the first seven articles. Emissions from Eu^{3+} in CdF_2 excited by ^{60}Co γ rays; radioluminescence of glass activated by rare-earth elements, variations of Young's modulus in silicon irradiated in a reactor, energy levels of γ-irradiated silicon, electrophysical properties of whiskers in silicon crystals, and resolving properties of charged-particle detectors are discussed in the remaining ten articles. (R.V.J.)

44533 ELECTRON CHANNELING IN THE CASE OF X-RAY K-RADIATION PRODUCTION IN SINGLE CRYSTALS. Bronder, Th.; Jakschik, J. Phys. Lett., 29A: 580-1(Aug. 11, 1969).

The K radiation yield increases by bombarding thin single-crystal films of silver with electrons not only in directions of crystallographic axis but also in planes. The half width of the peaks in the range of 200 keV is about 3°. (auth)

44534 THE SATURATION OF F-CENTRE FORMATION IN ALKALI METAL HALIDES UNDER ELECTRON IRRADIATION AT ROOM TEMPERATURE. Herrmann, F.; Pinard, P. (Institut National des Sciences Appliquees, Lyon). Phys. Lett., 29A: 584-5(Aug. 11, 1969).

It was found that F-center growth curves in alkali metal halide crystals irradiated with electrons of 5 to 45 keV at room temperature to saturation can be represented by the function $A = A_0(1 - 1/\sqrt{bt + 1})$. (auth)

Physical Properties

Refer also to abstracts 43982 and 44021.

44535 (NYO-2391-96) FAR INFRARED PROPERTIES OF DYSPROSIUM AND TERBIUM METALS. Report No. 1142. Marsh, Howard Stephen (Cornell Univ., Ithaca, N. Y. Materials Science Center). June 1969. Contract AT(30-1)-2391. 153p. Dep. CFSTI.

Thesis.

The surface impedances of polycrystalline Dy and Tb metals were measured in the far-infrared spectral region from 3 to 30 cm^{-1}. In a zero magnetic field, the ferromagnetic resonance was observed as a strong, broad peak in the surface resistance, and the frequency of this resonance was studied as a function of temperature from liquid-helium temperature to 153°K. The resonance frequency decreased from 24.4 cm^{-1} at 4.2°K to 10.5 cm^{-1} at 80°K in Dy and from 14.6 cm^{-1} at 4.2°K to 6.4 cm^{-1} at 153°K in Tb. The values of the uniaxial and hexagonal anisotropy constants were deduced from these observations. The anisotropy constants for Dy were $(2/3)K_2 = 4.9 \times 10^6$ ergs/cm^3 and $K_6 = 1.9 \times 10^7$ ergs/cm^3 at 0°K, and for Tb the values were $(2/3)K_2 = 4.5 \times 10^6$ ergs/cm^3 and $K_6 = 2.4 \times 10^6$ ergs/cm^3 at 0°K. Magnetoelastic interaction energies were extremely large in Dy and Tb, and the effects of these interactions on the long-wavelength spin-wave energies were considered. The far-infrared results are described by the frozen-lattice model first proposed by Turov and Shavrov and calculated for Dy and Tb by Cooper. A "two-sublattice model" for dynamic magnetoelastic interactions is presented, and this model shows that only the frozen lattice is physically possible at far infrared frequencies, while at lower frequencies a free lattice may be observed. (71 references) (auth)

44536 MAGNETIC PROPERTIES OF DILUTE GOLD-VANADIUM ALLOYS: NUCLEAR MAGNETIC RESONANCE IN AuV AND Au(Ag)V. Narath, Albert (Sandia Labs., Albuquerque, N. Mex.); Gossard, A. C. Phys. Rev., 183: 391-407(July 10, 1969).

The low-temperature (1 to 4°K) magnetic properties of dilute (0.1 to 10 at.%) AuV alloys were studied by means of pulsed NMR techniques. The previously reported ^{51}V line-shape anomaly for vanadium concentrations near 1 at.% is shown to result from a large reduction in the vanadium spin susceptibility for vanadium impurities that are nearest neighbors to each other. The observed change in the ^{51}V resonance shift from a negative value (−1.5%) at low vanadium concentrations to a positive value (+0.6%) at high concentrations is consistent with the expected variation in the ration of "nonmagnetic" to "magnetic" vanadium concentrations. The nuclear resonances are severely broadened as a result of oscillatory spin-density disturbances associated with d-resonance scattering of the host conduction electrons. There is no indication, however, that the field-induced impurity magnetization gives rise to significant long-range negative-definite spin polarizations in the host metal as suggested recently. This conclusion is supported by the absence of positive ^{109}Ag resonance shifts in ternary Au(Ag)V alloys containing up to 20 at.% silver. In general, measurements suggest that "magnetic" as well as "nonmagnetic" vanadium sites can be described by a virtual bound d-state model in which the impurity susceptibility, resonance shift, and nuclear spin relaxation rates are enhanced by local Coulomb interactions. The two types of vanadium sites are distinguished by different enhancement factors, or, equivalently, different spin-fluctuation frequencies. The ^{51}V spin-lattice relaxation rates T_1^{-1} are directly proportional to the absolute temperature over the entire composition range. In the infinite-dilution limit $T_1T \approx 17$ msec°K, while at high concentrations T_1T approaches the metallic vanadium value. An analysis of the infinite-dilution ^{51}V shift and relaxation-rate data indicates that the impurity-site spin susceptibility accounts for most of the measured bulk susceptibility. (auth)

44537 OPTICAL CONSTANTS OF Ta–W AND Nb–Mo ALLOYS AT INCANDESCENT TEMPERATURES. Thomas, L. K. (Technische Univ., Berlin). Z. Angew. Phys., 27: 209-13(July 8, 1969). (In German).

The optical constants of Ta–W and Nb–Mo alloys were measured at the wavelengths 0.538, 0.715, 0.985, and 1.4 μm using the angular dependence of the thermal radiation. The temperatures of the samples were 2400 and 2000°K. In the infrared range, the product of the optical constants changes with composition similarly to the electrical conductivity; in the visible range, there are maxima and minima. Relations between these results and the electronic density of states of the conduction band are discussed. (auth)

44538 THE EFFECT OF GRINDING ON THE DISLOCATION STRUCTURE OF AS-GROWN MOLYBDENUM SINGLE CRYSTALS. Luft, A.; Kaun, L. (Deutsche Akademie der Wissenschaften, Berlin. Teilinstitut fuer Metallphysik und Reinstmetalle, Dresden). Phys. Status Solidi, 34: 135-44(July 1, 1969).

The effect of centerless grinding and abrasion of zone-melted molybdenum single crystals on their dislocation structure is investigated by thin-foil transmission electron microscopy. The observations reveal that typical dislocation arrangements result from the mechanical pretreatment of the crystals. It is possible to distinguish between grown-in dislocations and those configurations introduced by grinding. In addition some etch pit studies are carried out to test the reliability of this method. The results are discussed in relation to adequate preparation of tensile specimens and correct analysis of electron micrographs. (auth)

44539 EVIDENCE FOR THE PRESENCE OF THE KONDO EFFECT IN THE COMPOUND $CeAl_2$. Buschow, K. H. J.; van Daal, H. J. (Philips Research Labs., Eindhoven, Netherlands). Phys. Rev. Lett., 23: 408-9(Aug. 25, 1969).

The anomalies present in the electrical resistivity of $CeAl_2$ have been suppressed by partial replacement of Ce by Th. It is argued that this substitution influences appreciably the density-of-states function of the conduction electrons at the Fermi surface. The result of the Th substitution is thought to bring further evidence in favor of the occurrence of the Kondo effect in $CeAl_2$. (auth)

44540 INVESTIGATION OF CHARGE COMPENSATION MECHANISMS OF TRIGONAL CENTERS IN CeO_2 BY THE ELECTRON-NUCLEAR DOUBLE RESONANCE METHOD. Zonn, Z. N.; Katyshev, A. N.; Mitrofanov, Yu. V.; Pol'skii, Yu. E. (Kazan State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 11: 284-7(Aug. 1969).

Translated from Fiz. Tverd. Tela, 11: 357-61(Feb. 1969).

The electron-nuclear double resonance method was used to study the mechanisms of charge compensation resulting in the formation of trigonal Dy^{3+}, Er^{3+}, and Yb^{3+} centers in CeO_2. It was found that the charge compensation of trigonal centers of type I was due to F^- ions which replaced O^{2-} ions in the corners of a cube nearest to the paramagnetic ions along the [111] direction. The main contribution to the superhyperfine structure of type I trigonal Er^{3+} centers was made by the dipole–dipole interaction of erbium and fluorine nuclei. (auth)

44541 EXCHANGE INTERACTION OF CONDUCTION ELECTRONS IN EuO DOPED WITH GADOLINIUM. Samokhvalov, A. A.;

Afanas'ev, A. Ya. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 11: 380-1(Aug. 1969).

Translated from Fiz. Tverd. Tela, 11: 483-4(Feb. 1969).

A single crystal of $Eu_{0.96}Gd_{0.04}O$ was grown and its magnetic and electrical properties were studied. The magnetic and electrical parameters were compared with those for EuO. The replacement of Eu^{2+} in EuO by four atomic percent Gd^{3+} leads to an electrical conductivity increase of 10 orders in magnitude, and to a corresponding rise in the Curie temperature of almost 60°K. The temperature dependences of the electrical conductivity and that of the thermal emf coefficient of $Eu_{0.96}Gd_{0.04}O$ correspond to a metallic conductivity character. (D.H.M.)

44542 EFFECTIVE MAGNETIC FIELDS AT LANTHANUM AND LUTETIUM NUCLEI DISSOLVED IN GADOLINIUM. Nikulin, E. I.; Kogan, A. V.; Patrikeev, Yu. B. (Ioffe Physicotechnical Inst., Moscow). Sov. Phys.-Solid State (Engl. Transl.), 11: 440-1 (Aug. 1969).

Translated from Fiz. Tverd. Tela, 11: 543-5(Feb. 1969).

Measurements of the nuclear component of the specific heat of ferromagnetic alloys La–Gd (9% La) and Lu–Gd (10% Lu) are reported. Measurements were carried out in the temperature range 0.06 to 0.16°K. It was found that the interaction of the quadrupole moment of the nucleus with electric field gradient made a contribution of 4% to the nuclear specific heat of the Lu–Gd alloy and less than 1% to the specific heat of the La–Gd alloy. It was deduced that the field was $H_{eff} = (0.7 \pm 0.2) \times 10^5$ Oe at the lanthanum nuclei and $H_{eff} = (2.8 \pm 0.3) \times 10^5$ Oe at the lutetium nuclei. (D.H.M.)

44543 PERMANENT MAGNETIC MATERIALS OF RARE EARTH–COBALT COMPOUNDS. Buschow, K. H. J.; Velge, W. A. J. J. (Philips Research Lab. and Metallurgical Lab., Eindhoven, Netherlands). Z. Angew. Phys., 26: 157-60(1969).

The magnetic properties of $CaZn_5$-type intermetallic compounds of cobalt and rare earth metals (including Th) are discussed. For the crystalline anisotropy extremely high values are reported (for $SmCo_5$ $H_A \approx 290$ kOe). By milling high coercive forces can be introduced (for $GdCo_5$ $_IH_c > 23$ kOe). It is shown that the values for both H_A and $_IH_c$ depend on the lattice parameters of the $CaZn_5$ structure and that H_A and $_IH_c$ are not dependent on the intrinsic magnetic properties of the rare earth atoms. Some of the cobalt rare earth compounds are useful starting materials for permanent powder magnets. For a magnet body built up from fine $SmCo_5$ particles an energy product of 8.1×10^6 GOe with a coercive force $_BH_c$ of more than 5000 Oe was obtained. (auth)

44544 EFFECT OF INHOMOGENEITY ON MAGNETIC PROPERTIES, X-RAY DIFFRACTION, AND ^{31}P NMR LINEWIDTHS IN $UP_{1-x}S_x$ POWDERS. Kuznietz, Moshe; Campos, F. P.; Baskin, Y. (Argonne National Lab., Ill.). J. Appl. Phys., 40: 3621-5(Aug. 1969).

The wide temperature range at which transitions occur between magnetic structures, and the coexistence of magnetic structures in the $UP_{1-x}S_x$ system are attributed to the incomplete homogeneity of the powder samples. The inhomogeneity affects the linewidths of the x-ray diffractometer traces, the ^{31}P nuclear magnetic resonance (NMR) lines in the paramagnetic state, and the magnetic properties of $UP_{1-x}S_x$. The firing treatment of UP broadens the x-ray lines, while a second homogenization of $UP_{0.72}S_{0.28}$ sharpens the x-ray and ^{31}P NMR lines and decreases the portion of the antiferromagnetic structure that coexists with the major ferromagnetic phase at low temperatures. The composition ranges (inhomogeneity widths) deduced from the x-ray line broadening are about $0.1x_0$, where x_0 is the mean sulfur concentration. The upper limits of the inhomogeneity widths obtained from the excessive ^{31}P NMR linewidths and the widths of the magnetic transitions are in fair agreement with the inhomogeneity widths based on the x-ray data. (auth)

44545 ELECTRICAL CONDUCTIVITY AND OXYGEN DIFFUSION COEFFICENT OF CeO_2 SINGLE CRYSTALS. Vinokurov, I. V.; Ioffe, V. A. (Inst. of Silicate Chemistry, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 11: 207-9(Aug. 1969).

Translated from Fiz. Tverd. Tela, 11: 257-60(Feb. 1969).

The temperature dependence of the diffusion coefficient of oxygen was measured in the 1040 to 1535°K range using "pure" CeO_2 single crystals, i.e., crystals containing $\sim 10^{-5}$ at. % Gd^{3+}, as well as crystals containing 0.3 at. % Gd^{3+} giving EPR spectra of cubic symmetry. The activation energy for the diffusion of oxygen in "pure" crystals was 3.2 ± 0.3 eV and in crystals with 0.3 at. % Gd^{3+}, this energy was 0.9 ± 0.3 eV. The electrical conductivity and thermoelectric power of CeO_2 + 0.3 at. % Gd^{3+} single crystals were measured in the temperature range 500 to 1500°K. The results obtained indicated that at low temperatures CeO_2 single crystals exhibited an ambipolar conduction involving oxygen vacancies $V_O^{\cdot\cdot}$ on the one hand and electron exchange between free oxygen vacancies on the other; in the most strongly oxidized crystals the anion conduction predominated. At high temperatures electrons were excited from oxygen vacancies into the conduction band and the electron conduction always suppressed the anion mechanism. (auth)

44546 TUNNELING PHENOMENA IN SOLIDS. Lectures Presented at the 1967 NATO Advanced Study Institute at Risoe, Denmark, June 19–30, 1967. Burstein, Elias; Lundqvist, Stig (eds.). New York, Plenum Press, 1969. 587p. $25.00. (CONF-670663).

The concepts of tunneling phenomena in solids and theoretical and experimental techniques for their investigation are considered. Topics covered include: basic concepts of tunneling, WKB methods, metal-insulator-metal tunneling, theory of metal-barrier-metal tunneling, interband tunneling, tunneling in Schottky barrier rectifiers, some properties of exponentially damped wave functions, image force in metal-oxide-metal tunnel junctions, phonon-assisted semiconductor tunneling, effect of stress on interband tunneling in semiconductors, excess currents in semiconductor tunneling, magnetotunneling effects in semiconductors, molecular excitations in barriers, tunneling between superconductors, tunneling density of states, many-body theory of tunneling, geometrical resonances in the tunneling characteristics of thick superconducting films, multiparticle tunneling, photon-assisted single-particle tunneling between superconductors, phonon generation and detection by single-particle tunneling in superconductors, unified theory of zero-bias anomalies and energy loss mechanisms in the barrier, gapless superconducting tunneling, Josephson effects, weakly coupled superconductors, and atomic tunneling in solids. (M.C.G.)

44547 NEUTRON-DIFFRACTION MEASUREMENTS OF THE MAGNETIC STRUCTURES AND FORM FACTORS OF THE RARE EARTH ELEMENTS. Will, G. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys., 26: 67-76(1969). (In German).

Magnetic ordering in crystals manifests itself in extra magnetic Bragg reflections in neutron diffraction diagrams. From the position and intensities of the peaks the magnetic structures can be derived. Especially complicated magnetic structures were found in the rare earth elements with structures varying from spiral or oscillating configurations to ferromagnetic ordering. The magnetic structures in the rare earth elements are determined by the anisotropy energies of the crystals. The quantitative evaluation of the magnetic scattering allows accurate determination of the local moments and of the magnetic form factors. Fourier inversion yields the local distribution of the magnetic moments throughout the crystal. Form factor measurement of Er and Tb are discussed. Tb was also measured with polarized neutrons, suggesting a negative moment contribution from the conduction electrons. The form factors of the rare earth ions seem to be mainly spherical. (auth)

44548 ReO_3 BAND STRUCTURE IN THE TIGHT-BINDING APPROXIMATION. Honig, J. M.; Dimmock, J. O.; Kleiner, W. H. (Massachusetts Inst. of Tech., Lexington). J. Chem. Phys., 50: 5232-42(June 15, 1969).

Using tight-binding, LCAO methodology, a formal band structure scheme was specified for the ReO_3 structure based on the use of 2s and 2p orbitals for oxygen and of 5d, 6s, and 6p orbitals for rhenium. The scheme should also be useful in the characterization of band structures for perovskites in general. Two sets of sufficient conditions were found under which the secular determinant reduces to two special cases: one corresponding to a model previously considered by Goodenough and the other to a model considered by Kahn and Leyendecker. The nature of the approximation schemes is discussed in some detail. (auth)

44549 THE HALL EFFECT IN V_2O_3 SINGLE CRYSTALS IN THE METALLIC CONDUCTIVITY REGION. Zhuze, V. P.; Andreev, A. A.; Shelykh, A. I. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 10: 2914-16 (June 1969).

Translated from Fiz. Tverd. Tela, 10: 3674-7(Dec. 1968).

Results of measurements of the temperature dependence of the electrical conductivity of V_2O_3 single crystals and the Hall effect in the metallic region are presented. The activation energy of the electrical conductivity in the semiconductor region was calculated to be equal to 0.6 eV. The values of the electric conductivity changed discontinuously at the temperature of phase transition (T_p) by 4 to 5×10^6 times. In the metallic conduction region $\partial\sigma/\partial T = -3.4 \times 10^{-3}\ \Omega^{-1} \cdot cm^{-1}/deg$. The density of holes, defined as $p = 1/Rce$ is equal to 3.5 to $4.2 \times 10^{22}\ cm^{-3}$ in several samples. The mobility of holes in the interval of the measurements varied from 0.55 at 200°K to 0.40 $cm^2/V \cdot sec$ at 300°K. (D.H.M.)

44550 ELECTRICAL TRANSPORT AND THE SORET EFFECT IN MOLYBDENUM. Vasil'kovskii, D. N.; Zakurdaev, I. V.

(Radiotechnical Inst., Ryazan, USSR). Sov. Phys.-Solid State (Engl. Transl.), 10: 2886-90(June 1969).
Translated from Fiz. Tverd. Tela, 10: 3640-6(Dec. 1968).

The electrical and thermal transport of matter in molybdenum, a hole-type conductor, was investigated at temperatures from 1650 to 1900°C. The direction and velocity of transport of the ions could be determined from the motion of marks on the metal surface. The samples were heat-treated in vacuo, at pressures below $2 \cdot 10^{-7}$ mm Hg. The marks were displaced appreciably at 1850°C and higher. In the presence of a direct current the ions moved toward the cathode; in a temperature-gradient field they moved toward the cold end. The rate of displacement of the marks in the electric field was equal to 0.8 μ per 10-hr period at T = 1900°C and current density $j = 1.4 \times 10^4$ A/cm^2. The average effective charge at 1800 to 1900°C was equal to 32. In the temperature-gradient fields the marks were shifted at the rate of 2 μ per 10-hr period at T = 1870°C. Directed transport of matter gives rise to a peculiar stepped structure on the surface of a molybdenum wire. The slight temperature dependence and anomalously high growth rate of the steps support the mechanism of cooperative displacement of atoms. It is proposed that in metals in which stacking-fault energy is large, such displacement may be due to directed motion of dislocations in the electric and temperature-gradient fields. The effective charge was calculated from data on the growth of steps on the metal surface. The value of Z* obtained in this case is evidently closest to the true effective charge of the molybdenum ion. (auth)

44551 MELTING OF SUBCRITICALLY THIN CONDENSED FILMS OF INDIUM. Boiko, B. T.; Pugachev, A. T.; Bratsykhin, V. M. (Polytechnical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.), 10: 2832-4(June 1969).
Translated from Fiz. Tverd. Tela, 10: 3567-70(Dec. 1968).

The melting of subcritically thin condensed indium films was investigated by means of electron diffraction. These same films were also investigated with an electron microscope and a histogram was constructed for each film, which made it possible to determine the most probable particle size $\bar{L}$. In the films that were investigated $\bar{L}$ was found to have values falling between 100 and 400 Å. A method of calculating the effective thickness of subcritical films from electron microscope data is proposed. It is shown that the melting of subcritical films does not occur at a definite temperature but rather over an interval of temperatures that depends on the width of the fundamental maximum on the histogram. The change in the specific surface energy at melting was found to be 110 ± 20 ergs/cm^2. (auth)

44552 LOCALIZED MAGNETIC MOMENTS IN Nb-Co AND Zr-Co ALLOYS. Krivko, N. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 11: 334-6(Aug. 1969).
Translated from Fiz. Tverd. Tela, 11: 423-6(Feb. 1969).

The EPR method is used to determine the shift in the g factor and to investigate the localized magnetic moments formed by cobalt impurity in both niobium and zirconium. Above a certain temperature both the localized magnetic moments and the EPR signal disappear. The temperature dependence of the g factor could be caused by the formation of bound states in these alloys at helium temperatures. (auth)

44553 COMPILATION OF ELASTIC WAVE MODES IN HEXAGONAL METALS. Henneke II, Edmund G.; Green, Robert E. Jr. (Johns Hopkins Univ., Baltimore). J. Appl. Phys., 40: 3626-32 (Aug. 1969).

Elastic wave velocities, particle displacement vectors, and directions of energy flux were calculated and are given as a function of the polar angle θ in the five hexagonal metals Be, Cd, Mg, Ti, and Zn. Because of elastic transverse isotropy around the hexagonal axis, the wave characteristics are functions of the angle between the hexagonal axis and the direction of propagation in the crystal only. The results of these calculations are especially useful for experimental investigations utilizing the ultrasonic pulse-echo technique. (auth)

44554 ORIENTATION DEPENDENCE OF DISLOCATION DAMPING IN HEXAGONAL METALS. Henneke II, Edmund G.; Green, Robert E. Jr. (Johns Hopkins Univ., Baltimore). J. Appl. Phys., 40: 3632-41(Aug. 1969).

The orientation dependence of dislocation damping in the five hexagonal metals Mg, Cd, Be, Zn, and Ti was predicted by calculation of the appropriate factors relating the stress field of the elastic waves to the slip systems in which the dislocations are moving. The four metals having basal slip systems have very similar qualitative behavior of the orientation factors. Titanium, with prismatic slip systems, has a quite different behavior and the orientation factors are smaller for all orientations than the values for the basal slip metals. For Zn, Cd, Mg, and Ti, the values of the orientation factors for standing waves (resonance technique) are larger than the corresponding values for the traveling waves (pulse-echo technique). For Be, the orientation factors for both types of waves are nearly equal. Crystal orientations and wave types of particular interest for experimental study are delineated. (auth)

44555 POSITRON ANNIHILATION IN γ- AND α-CERIUM. Gustafson, D. R.; McNutt, J. D.; Roellig, L. O. (Wayne State Univ., Detroit). Phys. Rev., 183: 435-40(July 10, 1969).

The $\gamma \rightarrow \alpha$ phase transition of cerium was investigated by measurement of the positron lifetime and angular correlation of positron-annihilation radiation in the two phases. The lifetime in the α phase was 8% shorter than the lifetime in the γ phase when the α phase was produced by the application of pressure; and it was 5% longer when the α phase was produced by lowering the temperature. The angular correlation from α-cerium produced by pressure was observed to be slightly broader than that from γ-cerium, in contrast to the narrowing previously observed when α-cerium was produced by lowering the temperature. Since the observed changes are much smaller than predicted by models which explain the $\gamma \rightarrow \alpha$ transition by assuming a transfer, or partial transfer, of the 4f electron to the conduction band, it is concluded that such electronic promotion does not occur. (auth)

44556 HIGH-FIELD GALVANOMAGNETIC PROPERTIES OF $AuAl_2$, $AuGa_2$, AND $AuIn_2$. Longo, J. T. (Michigan State Univ., East Lansing); Schroeder, P. A.; Sellmyer, D. J. Phys. Rev., 182: 658-70(June 15, 1969).

Measurements of the magnetoresistance and Hall voltage were made in the high-field region on the metallic fluorite compounds $AuAl_2$, $AuGa_2$, and $AuIn_2$. The results were compared with those expected from the nearly-free-electron (NFE) model. These compounds are uncompensated. The magnetoresistance measurements in principal planes and directions, with one exception, support the NFE model, but the dimensions of the two-dimensional areas of aperiodic open orbits show pronounced deviations. Hall-effect measurements for B in the ⟨100⟩ and ⟨111⟩ directions indicate significant departures of the real Fermi surface from the NFE model. A proposed empirical model gives much better agreement with Hall-effect, magnetoresistance, and de Haas–van Alphen measurements. In the best $AuGa_2$ crystal, magnetoresistance whiskers have been observed and classified in some detail. The magnetoresistance has been calculated for B in the {100} plane, assuming a constant relaxation time and a model of the fourth electron zone with a topography similar to the NFE Fermi surface. (auth)

44557 PROCESS FOR IMPLANTING BURIED LAYERS IN SEMICONDUCTOR DEVICES. Dolan, Russell P. Jr.; Roosild, Sven A. (to Secretary of the Air Force). U. S. Patent 3,457,632. Filed Oct. 7, 1966.

A method is presented for forming semiconductor electronic devices by ionic bombardment. The method includes the steps of placing an ion-absorbing mask of semiconductor substrate, bombarding the substrate with monoenergetic ions, and heating the material to repair radiation damage. (AEC)

Moessbauer Effects and NMR

Refer also to abstracts 43347, 43574, and 43576.

44558 TEMPERATURE DEPENDENCE OF THE ^{115}In NUCLEAR-MAGNETIC-RESONANCE SPECTRUM IN THE INTERMETALLIC COMPOUND InBi. Setty, D. L.; Radhakrishna; Mungurwadi, B. D. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 183: 387-91(July 10, 1969).

The NMR spectrum of ^{115}In in the intermetallic compound InBi was recorded in the temperature range 77 to 390°K. The Knight shift and the quadrupole coupling constant at the site of the ^{115}In nucleus at each temperature were determined. The Knight shift is positive at higher temperatures, decreases with decreasing temperature, and changes sign at about 230°K, whereas the quadrupole coupling constant, which is also a function of temperature, passes through zero at about 170°K. The results were discussed in the light of the crystal structure of the compound. It was shown that core polarization is responsible for the observed negative Knight shift at low temperatures. (auth)

44559 CALORIMETRIC INVESTIGATION OF THE HYPERFINE INTERACTIONS IN METALLIC Nd, Sm, AND Dy. Anderson, A. C.; Holmstroem, B.; Krusius, M.; Pickett, G. R. (Technical Univ. of Helsinki, Otaniemi, Finland). Contract AF61 (052)-956. Phys. Rev., 183: 546-52(July 10, 1969).

The specific heats of metallic Nd, Sm, and Dy were measured in the temperature range 0.025 to 0.4 K, where the nuclear (hyper-

fine) heat capacity predominates. The data are fitted to theoretical Schottky curves corresponding to a Hamiltonian of the form $H = a'I_z + P[I_z^2 - \frac{1}{3}I(I+1)]$, where a′ and P are the magnetic dipole and electric quadrupole interaction parameters, respectively. The Nd data are consistent with a two-sublattice model with the electronic moments on each sublattice appreciably less than the full saturation value. Both the Sm and Dy data fit Schottky anomalies corresponding to the full saturated electronic moment on each ion. (auth)

44560 SPIN-ECHO MEASUREMENTS OF SPIN–SPIN INTERACTIONS IN METALS: TIN AND CADMIUM. Alloul, H.; Deltour, R. (Faculte des Sciences, Orsay, France). Phys. Rev., 183: 414-21(July 10, 1969).

Modulated structure of the nuclear spin-echo envelope was studied in metallic solid solutions. The modulation is due to microscopic broadening of the NMR line. The modulation period $2\tau_M$ was calculated as a function of the two coupling constants J (exchange) and B (total dipolar), taking into account the signs of these interactions. In order to examine the effect of departures from the hypotheses of the theory, the dc field variation of the spin-echo envelopes was studied in a Pt–Au alloy with rf fields smaller than the linewidth. Modulated echo envelopes were observed in cadmium- and tin-based alloys. In the Cd–Mn system, two modulations of the ^{111}Co signals were present, whose corresponding periods $2\tau_M$ were 3.1 ± 0.15 and 4.2 ± 0.2 msec. In tin alloys, one frequency only could be resolved for ^{119}Sn corresponding to $2\tau_M$ = 0.54 ± 0.04 msec. The measured second moments of the lines of pure Cd and pure Sn, together with the preceeding data, were used to obtain the value of the exchange coupling J for the first nearest neighbors (J = 4.1 kHz for Sn, J = 0.5 kHz for Cd), while an order of magnitude was deduced for the pseudodipolar interaction. A similar analysis was applied to previous measurements on lead. The results are discussed and compared with estimates based on the Ruderman–Kittel approximation. (auth)

44561 NUCLEAR MAGNETIC RESONANCE OF THE DEUTERON IN LANTHANUM DIDEUTERIDE AT LOW TEMPERATURES. Barrere, Helene (CNRS, Paris). Compt. Rend., Ser. C, 268: 754-7(Mar. 3, 1969). (In French).

A thorough study of the deuteron resonance in the phase LaD_2 of a $LaD_{1.40}$ sample is compared with a previous study of a $LaD_{1.85}$ sample. Differences between the two compositions in the widths and second moments of the lines from −185 to 25°C are shown. The deviations with the theoretical value of the second moment are explained by a weak quadrupole interaction due to the presence of imperfections in the lattice of the dideuterides: the calculation of q and e^2qQ/h for the two samples is compatible with the preceding hypothesis. The times T_1 measured at ambient temperature are coherent with those due to a process of relaxation by spin scattering from the paramagnetic impurities. (tr-auth)

44562 ANNUAL REVIEW OF NMR SPECTROSCOPY. VOLUME 2. Mooney, E. F. (ed.). London, Academic Press, 1969. 467p. 120s.

The subject is reviewed under the following main headings: general review of proton magnetic resonance; NMR spectroscopy in the study of carbohydrates and related compounds; solvent effects in proton magnetic resonance spectroscopy; nitrogen magnetic resonance spectroscopy; ^{13}C NMR spectroscopy – ^{13}C chemical shifts and coupling constants; ^{11}B NMR spectroscopy; nuclear electron double resonance in liquids; ^{31}P NMR spectra of coordination compounds. (UK)

44563 NUCLEAR MAGNETIC RESONANCE IN SINGLE-CRYSTAL NIOBIUM. Schone, Harlan E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., 183: 410-13(July 10, 1969).

The ^{93}Nb was observed in cylindrical single crystals of niobium metal. The linewidth and second moment were studied as a function of angle at 77°K and 10 kG. Both a highly anisotropic contribution to the second moment and the narrowing effect of an isotropic exchange interaction were observed. (auth)

44564 RADIATIVE DETECTION OF NUCLEAR MAGNETIC RESONANCE. Shirley, D. A. (Univ. of California, Berkeley). Anal. Chem., 41: No. 8, 69A-70; 72A; 74A(July 1969).

Applicable to metastable nuclear states, radiative detection of NMR (NMR/RD), employs beta or gamma radiation to detect resonance. The distribution of radiation from oriented nuclei and three methods for orienting nuclei are discussed. The power requirements for producing observable resonances in oriented nuclear spin systems are considered. Results to date with this method are reviewed. (M.C.G.)

44565 INFLUENCE OF ION–PHONON INTERACTION ON RESONANCE ABSORPTION OF GAMMA QUANTA IN A PARAMAGNETIC CRYSTAL. Bashkirov, Sh. Sh.; Selyutin, G. Ya. (Kazan State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 11: 271-4(Aug. 1969).

Translated from Fiz. Tverd. Tela, 11: 339-44(Feb. 1969).

The influence of an ion–phonon interaction on the intensity of a Moessbauer spectrum and on the one-phonon effective cross section for absorption of gamma quanta is considered in a paramagnetic crystal. It is shown that in crystals containing paramagnetic ions with a relatively strong ion–phonon interaction, the latter can lead to a pronounced change in the intensity of the Moessbauer line. The ion–phonon interaction also leads to the appearance of resonance-type maxima in the phonon wings of the gamma spectra. (auth)

44566 OBSERVATIONS ON IMPLANTED ^{133}Xe SOURCES. de Waard, H.; Drentje, S. A. (Univ. of Groningen, Netherlands). Proc. Roy. Soc. (London), Ser. A, 311: 139-50(June 24, 1969).

Moessbauer spectra of the 81-keV line of ^{133}Cs excited in the decay of ^{133}Xe implanted in iron are presented for a large range of xenon concentrations. The spectra indicate that there are two main locations for the Xe atoms: high field sites, with $|H| = 273 \pm 10$ kOe and an isomer shift $\delta_H \simeq -1.1$ mm/s, and low (or zero) field sites, with $|H| < 25$ kOe and $\delta_0 = -0.2$ to -0.4 mm/s. For doses below about 2×10^{14} Xe atoms/cm^2 (implanted at 50 keV) the intensity ratio of the Moessbauer spectra of Cs nuclei at high and low field sites varies irregularly between 0.1 and 0.3, while at a high dose (~10^{15} at./cm^2), and also after annealing foils with a low dose, this ratio becomes large. The considerable spread of the isomer shifts at low field sites may arise from nonequivalence of these sites, at which the Xe atoms are supposed to have formed clusters. The remarkably large isomer shift for the high field sites, for which the Xe atoms are believed to be substitutionally implanted, could be caused by promotion of about two 5p electrons to the conduction band. Spectra are also presented for ^{133}Xe sources implanted in vanadium and chromium. The source in vanadium again gives evidence of the existence of two different sites, presumably a cluster site and a substitutional site. The source in chromium shows one broad line with large isomer shift. (auth) (UK)

44567 MOESSBAUER EFFECT WITH ^{57}Fe FOLLOWING NEUTRON CAPTURE IN ^{56}Fe. Berger, W. G. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 225: 139-63(1969). (In German).

Moessbauer effect measurements with the 14.4-keV gamma rays of ^{57}Fe following thermal neutron capture in ^{56}Fe are reported. During the transition from the capture level at 7.6 MeV to the first excited state at 14.4 keV, recoil energies up to 549 eV are imparted to the ^{57}Fe nuclei. Thus, the Moessbauer gamma rays are emitted by nuclei displaced from their normal lattice positions. The measurements were performed in order to get information about the final position of the recoiled nuclei in metallic iron and in ordered Fe–Al alloys. Moessbauer spectra of recoil atoms in metallic iron did not show any significant deviation from the spectra of atoms on normal lattice positions. In ordered FeAl alloys of CsCl structure, changes in the isomer shift due to recoil effects were found. In a Fe_3Al alloy of DO_3-type order, additional changes in the internal magnetic field were observed. All results are discussed in terms of possible final positions for the primary recoiled iron atoms in the lattice. (auth)

44568 A VERSATILE COMPUTER PROGRAM FOR ANALYSIS OF MOESSBAUER SPECTRA. Agresti, D.; Bent, M.; Persson, B. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Instrum. Methods, 72: 235-6(1969).

The features of a program to analyze Moessbauer spectra are described. The program is fast, can easily be extended, and has been successfully used to fit a large variety of spectra. Complementary spectra can be analyzed in a single least-squares procedure. (auth)

44569 MAGNETIC AND NUCLEAR-RESONANCE PROPERTIES OF SINGLE-CRYSTAL SCANDIUM. Ross, J. W.; Fradin, F. Y.; Isaacs, L. L.; Lam, D. J. (Argonne National Lab., Ill.). Phys. Rev., 183: 645-52(July 15, 1969).

Magnetic-susceptibility, magnetic-anisotropy, and nuclear-magnetic-resonance measurements were performed on single-crystal scandium samples from 4.2 to 300°K. The susceptibility of single-crystal scandium is greater along the a axis than along the c axis. The nuclear relaxation rate $(T_1T)^{-1}$ has a $\sin^2\theta$ dependence on the angle between the static magnetic field and the crystallographic c axis. The orbital hyperfine interaction is the major contribution to the relaxation rate. From the experimental results, values are estimated for the electronic density of states, the average fractional s character, the average fractional admixture coefficients for d electrons at the Fermi surface, and the orbital paramagnetism. (auth)

44570 ON POINT-CHARGE CALCULATION OF THE QUADRUPOLE SPLITTING IN MOESSBAUER SPECTRA. Gelberg, A.

(Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 183-8(1969).

The quadrupole splitting of a Moessbauer line is calculated. The formula derived is valid in any coordinate frame. This result is applied to the Moessbauer quadrupole splitting of a ^{57}Fe trivalent ion occupying an octahedral site of a spinel lattice. (auth)

44571 MOESSBAUER ISOMER SHIFT IN ^{243}Am. Kalvius, G. M.; Ruby, S. L.; Dunlap, B. D.; Shenoy, G. K.; Cohen, D.; Brodsky, M. B. (Argonne National Lab., Ill.). Phys. Lett., 29B: 489-90(July 21, 1969).

The nuclear γ-ray resonance of the 83.9-keV level in ^{243}Am was observed. The measured isomer shift between AmO_2 and AmF_3 was used to calculate $\delta\langle r^2\rangle/\langle r^2\rangle$ to be $-(9 \pm 3) \times 10^{-4}$. The nuclear parameters are compared with those of ^{237}Np. (auth)

Theoretical Physics

Refer also to abstracts 43581, and 44989.

44572 A COVARIANT FORMULATION OF RELATIVISTIC QUANTUM STATISTICAL MECHANICS. I. PHASE SPACE DESCRIPTION OF A RELATIVISTIC QUANTUM PLASMA. Balescu, R. (Univ. Libre, Brussels. Univ. of Texas, Austin). Acta Phys. Aust., 28: 336-52(1968).

A generalization of the Wigner distribution function is derived for the description of an electron–positron field interacting with a photon field. The relation of this distribution function to the density matrix is discussed in detail. Neither the number of photons, nor the number of electrons and positrons is fixed in this description, but the total number of charges is considered as a given constant. The physical interpretation of the less-customary electron–positron distribution is thoroughly analyzed. (auth)

44573 SOME ASPECTS OF RELATIVISTIC STATISTICAL MECHANICS. Pina, E.; Balescu, R. (Univ. Libre, Brussels). Acta Phys. Aust., 28: 309-19(1968).

Three types of problems are studied: 1. The relativistic status of the concepts of homogeneous and of stationary systems is examined. It is proved in particular that under a Lorentz transformation a homogeneous system goes over into a homogeneous system only if it is also stationary, similarly a stationary system goes over into a stationary one if and only if it is also homogeneous. The relativistic invariance of the equilibrium distribution follows. 2. It is shown that the tensorial character of the current–density vector and of the energy–momentum tensor depends crucially on Currie's condition of covariance of the particle trajectories. Hence these conditions cannot be discarded (as has been recently suggested) without coming in contradiction with well-established facts of macroscopic physics. 3. The transformation properties of the reduced one-particle distribution functions are studied. It is shown that the complete one-particle distribution function in μ space is a scalar, thus confirming a property postulated earlier. It is shown that the one-particle momentum distribution is a typical "nongeometrical" quantity, whose transformation law depends on the nature of the dynamical system it describes. (auth)

44574 SCATTERING OF RADIATION IN QUANTUM MECHANICS. Halpern, Otto (American Express Co., London). Acta Phys. Aust., 28: 359-66(1968).

It is shown that no equivalence has as yet been established between the formulas for scattering derived by assuming validity for two schemes in an earlier paper (Phys. Rev., 84: 997(1951)). It is furthermore shown that the present views about Delbrueck's scattering are hardly tenable; nuclear and electronic scatterings are in general not separable from each other. Any experimental search for Delbrueck's scattering suffers from lack of knowledge of an exact scattering formula. As the main result of the present investigation it is stated that an exact derivation of the scattering formula does not exist yet on the basis of scheme II; in particular, this statement refers not only to the case of hard quanta but also to the scattering of soft quanta, for which it previously was believed that general equivalence exists between the two schemes. The problem of scattering from nuclei (Delbrueck scattering) has assumed a new meaning. Electronic and nuclear scattering can hardly be called separable any longer. Any experimental investigation of the Delbrueck scattering is meaningless, as long as no exact comparisons with the scattering formula are available. (auth)

44575 MANY-BODY PROBLEMS. Parry, W. E.; Turner, R. E.; ter Haar, D.; Rowlinson, J. S.; Chester, G. V.; Hugenholtz, N. M.; Kubo, R. Progress in Physics, a Reprint Series. New York, W. A. Benjamin, Inc., 1969. 270p. $12.50 clothbound; $3.95 paperbound.

Topics include Green functions in statistical mechanics, theory and applications of the density matrix, the equation of state of dense systems, the theory of irreversible processes, quantum theory of many-body systems, and the fluctuation–dissipation theorem. (W.H.K.)

44576 QUANTUM THEORY OF STRUCTURE AND DYNAMICS. Allen, Leland C. (Princeton Univ., N. J.). Annu. Rev. Phys. Chem., 20: 315-56(1969).

Literature published during 1967 and 1968 is reviewed under the following topics: development of simplified electronic structure theory; development of schemes for constructing ab initio wave functions; ab initio wave functions and computed properties; long range forces between atoms and molecules; the interaction of radiation with matter; chemical dynamics and scattering theory; general methods and mathematical topics; and, development of chemical concepts. (659 references.) (J.G.B.)

44577 DERIVATION OF KINETIC EQUATION, UP TO ORDER λ^6, FOR THE INTERACTION BETWEEN RADIATION AND A TWO-LEVEL SYSTEM. PART II. Henin, F.; De Haan, M. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 54: 1056-90 (1968).

In a previous paper, the kinetic equation for the bare-particle distribution function up to order λ^6 for the interaction of a two-level system with radiation was discussed. Here, the transformation to quasi particles (Boltzmann representation) is performed, and a simple picture of the evolution of the system is obtained. (auth)

44578 QUANTUM MECHANICAL BASIS OF THE WIEDEMANN–FRANZ LAW. Narnhofer, H. (IUniv., Vienna); Thirring, W.; Sexl, R. Acta Phys. Austr., 28: 149-64(1968). (In German).

For the case of a discontinuity in temperature or in potential the Wiedemann–Franz law has been derived for free particles exactly. The result is a formula which is correct for Bose and Fermi statistics as well as for Boltzmann statistics. The calculation is done by means of the correlation functions and independently by a more direct and intuitive method which is specially adapted to the problem. (auth)

44579 TRANSVERSE DIELECTRIC CONSTANT OF THE DEGENERATE ELECTRON GAS. Trenchard, Herbert Allen. College Park, Md., Univ. of Maryland, 1968. 170p.

Thesis.

The response function measuring the intensity of the interaction between an electromagnetic wave and a degenerate electron gas is studied in detail. In particular, the frequency and wave-number-dependent transverse dielectric constant defined by Maxwell's field equations is derived in terms of a sum over the quantum mechanical interaction matrices of this system. Using the methods of second quantization and representing the interaction matrices in terms of Feynman diagrams, the imaginary part of the transverse dielectric constant is shown to be given strictly in terms of a set of irreducible Feynman diagrams. The imaginary part of the transverse dielectric constant is calculated using this formalism. When electron–electron interactions are included, it is found necessary to include certain sums of high order irreducible diagrams to avoid mathematical divergencies in the results. In particular, the electron self-energy must be included in the electron-hole propagator. The Coulomb interactions must be modified with a static shielding parameter. Further, a sum over multiple scatterings between electrons and holes must be used. Using these modifications an accurate value of the low frequency, long-wavelength transverse dielectric constant is obtained. The effect on the transverse dielectric constant of a constant magnetic field directed parallel to the electromagnetic wave momentum vector is also calculated. Electron–electron effects are included in this portion of the analysis to the same order as the zero-field analysis. The transverse dielectric constant is also calculated at high frequencies up to and above the electron plasma frequency. It is shown that these high frequency results are due to the frequency-dependent nature of the shielding parameter of the Coulomb interaction. It should be noted that there are no strong absorptions in this high-frequency region. Finally, a correction to the ground-state energy of the degenerate electron gas due to transverse interactions is calculated. It is found that the exchange and correlation energies are both quite small compared to the same energies calculated from the Coulomb interaction. (Disser. Abstr.)

44580 MOTION OF A PARTICLE IN A LINEAR PERIODIC ARRAY OF SMALL RADIUS POTENTIAL WELLS IN QUANTUM MECHANICS. Demkov, Yu. N.; Subramanyan, R. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz., 57: 698-702(Aug. 1969). (In Russian).

The problem of motion of a particle in a one-dimensional peri-

odic array of small-radius potential wells is considered. Closed expressions are obtained for the energy band, band width, and effective mass of a particle moving in such a field. It is shown that, in the case for a well of arbitrarily small depth, a negative energy state should exist. The wave function obtained is, in fact, a Green function and can be employed for solving the general problem of motion of a particle in the field of a linear periodic array in three-dimensional space. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 43600.

44581 TOTAL AND PARTIAL PHOTOPRODUCTION CROSS SECTIONS AT 1.44, 2.8, AND 4.7 GeV. Ballam, J. (Stanford Linear Accelerator Center, Calif.); Chadwick, G. B.; Gearhart, R.; (and others). Phys. Rev. Lett., 23: 498-501(Sept. 1, 1969).

A nearly monochromatic high-energy photon beam produced by Compton backscattering of ruby laser light was used to study photoproduction in a hydrogen bubble chamber. The total hadronic γp cross sections at 1.44, 2.8, and 4.7 GeV are found to be 145.1 ± 5.7, 131.3 ± 4.3, and 124.2 ± 3.9 μb, respectively. Partial cross sections are presented also. (auth)

44582 π^+-π^- PRODUCTION IN e^+e^- COLLISIONS AND ρ-ω INTERFERENCE. Augustin, J. E.; Benaksas, D.; Buon, J.; (and others) (Ecole Normale Superieure, Orsay, France). Nuovo Cim., Lett., 2: 214-19(Aug. 11, 1969).

Two-body reactions of the type $e^+e^- \rightarrow \pi^+\pi^-$ were measured at 2×290 to 2×470 MeV in the Orsay storage ring. The experimental data were fitted with the formula for the parametrization of the pion form factor with and without the ω-ρ interference hypothesis. The results indicated a strong ω-ρ coupling, although the possibility that the results correspond to a statistical fluctuation is not excluded. (L.B.S.)

44583 PHOTOPRODUCTION OF π^0 WITH PLANE POLARIZED 3-GeV PHOTONS. Bellenger, D.; Bordelon, R.; Cohen, K.; Deutsch, S. B.; Lobar, W.; Luckey, D.; Osborne, L. S.; Pothier, E.; Schwitters, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 23: 540-2(Sept. 8, 1969).

The cross section for photoproduction of π^0 mesons was measured at a photon energy of 3 GeV and squared four-momentum transfer (t) of -0.1 to -1.2 $(\text{GeV}/c)^2$ using plane-polarized photons. The asymmetry was found to be consistent with +1.0 for t values above -0.4 and below -1.1. For $-0.4 \leq t \leq -1.0$ there is a dip in the asymmetry and at $t = -0.6$ it drops to 0.55 ± 0.15. This result precludes a simple Regge model with ω^0 and B; a theoretical description requires Regge cuts or an ω' exchange. (auth)

44584 INCOHERENT PHOTOPRODUCTION OF ρ^0 MESONS FROM COMPLEX NUCLEI AND COMPARISON WITH VECTOR-DOMINANCE PREDICTIONS. McClellan, G. (Cornell Univ., Ithaca, N. Y.); Mistry, N.; Mostek, P.; Ogren, H.; Osborne, A.; Silverman, A.; Swartz, J.; Talman, R.; Diambrini-Palazzi, G. Phys. Rev. Lett., 23: 554-6(Sept. 8, 1969).

Vector-meson dominance predicts a characteristic energy dependence of incoherent ρ photoproduction from complex nuclei. Measurements of this process were made which do not conform to these predictions. (auth)

Weak

Refer also to abstract 44214.

44585 (AD-685789) MEASUREMENT OF THE ANGULAR CORRELATION COEFFICIENT IN NEUTRON DECAY. Final Scientific Report, February 1, 1965-January 31, 1969. Weinzierl, Peter; Paul, Helmut (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). Feb. 19, 1969. Contract AF61(052)-857. 13p. (AFOSR-69-896-TR). CFSTI.

The preparatory stages of an experiment to measure the angular correlation constant in a neutron beta decay are described. Neutrons will decay in the central part (next to the core) of a tangential beam tube of the ASTRA reactor. The decay protons fly over a distance of about 4 m into a spherical condenser electrostatic spectrometer and will finally be accelerated and counted by means of a coincidence ion-electron converter. A proton source at the other extreme of the beam tube will inject a precisely controlled beam of simulated decay protons at regular intervals, so that the constancy of transmission and of detection efficiency can be monitored in between spectrum measurements. The experiment requires low-background counting and the maintenance of low magnetic fields, low pressure and low electric fields under intense gamma and neutron irradiation. In preliminary investigations, the effect of neutron irradiation on soft magnetic materials, outgassing rates under reactor irradiation, and the effectiveness of magnetic shielding were investigated. The shape of the proton spectrum, the influence of magnetic and electric fields upon the proton transmission, and corrections due to motion of the decay neutrons, and to finite spectrometer resolution, were calculated. Most of the apparatus has been built. (auth)

44586 (NP-17984) WEAK INTERACTIONS. Lannoy, Fr. G.; Nuyts, J. (Institut Interuniversitaire des Sciences Nucleaires, Brussels (Belgium)). Sept. 1968. 80p. (In French). Dep.

The generalities of spontaneous decay are described. The mean lifetimes of the fundamental particles, their observed decay modes and branching ratios are given. The principle results are collected in tables and include experimental results from the fall of 1968. The Fermi universal interaction law and selection rules are also discussed. (J.F.P.)

44587 MEASUREMENT OF THE RELATIVE PHASE OF THE $K_L \rightarrow \pi^+\pi^-$ AND $K_S \rightarrow \pi^+\pi^-$ DECAY AMPLITUDES BY "VACUUM REGENERATION." Jensen, D. A. (Univ. of Chicago); Aronson, S. H.; Ehrlich, R. D.; Fryberger, D.; Nissim-Sabat, C.; Telegdi, V. L.; Goldberg, H.; Solomon, J. Phys. Rev. Lett., 23: 615-19 (Sept. 15, 1969).

The nonexponential $\pi^+\pi^-$ decay of neutral K's, due to the interference of K_S and K_L in this common channel, has been quantitatively studied using a beam which is preponderantly K^0 at t = 0. The value (40 ± 5)° is obtained for arg η_+ ($\eta_+ = \langle\pi^+\pi^-|T|K_L\rangle / \langle\pi^+\pi^-|T\times|K_S\rangle$), using $\Delta m/\hbar = (M_L - M_S)/\hbar = 0.538 \times 10^{10}$ sec^{-1}; allowing for the current uncertainty in Δm, the error in arg η_+ becomes ±12.5°. This result agrees with the predictions of that class of theories which give arg $\eta_+ \simeq \tan^{-1}(2\Delta m/\hbar\Gamma_S)$, in particular the "superweak" theory, for which this prediction is exact. (auth)

44588 MEASUREMENT OF THE MUON POLARIZATION VECTOR IN $K^+ \rightarrow \pi^0 + \mu^+ + \nu$. Cutts, David. Berkeley, Calif., Univ. of California, 1968. 132p.

Thesis.

The parameter ξ was determined in the decay $K^+ \rightarrow \pi^0 + \mu^+ + \nu(K_{\mu 3})$ from a muon polarization measurement carried out with spark chambers at the Bevatron. The parameter ξ, which may be complex and energy dependent, describes phenomenologically the manner in which the basic weak interaction responsible for the $K^+ \rightarrow \pi^0 + \mu^+ + \nu$ decay is modified by the strong interactions of the K and π mesons. Because ξ is determined by the structure of the K and π mesons, ξ is frequently called a form factor. The muon polarization vector was measured in $K_{\mu 3}$ decay and thereby ξ was determined. In the experiment K^+ mesons from a 500 MeV/c separated beam were brought to rest in a carbon stopper surrounded by lead-plate spark chambers to detect the two photons from the π^0. Muons were stopped in a magnetic-shielded aluminum-plate spark chamber. The data consist of 3133 events with μ-e decays and complete kinematics for $K^+_{\mu 3}$. From the angular distribution of the decay electrons the vector giving the polarization was determined, and this measurement was related to a determination of the parameter ξ. The data are statistically consistent with the assumption that ξ does not depend on momentum transfer. Assuming ξ constant, the result is $\xi = (-0.9^{+0.3}_{-0.2}) + i(-0.3 \pm 0.5)$. This result is compatible with $\text{Im}\xi = 0$ as would be required by time-reversal invariance. If the data are analyzed imposing the constraint that ξ be real it is found that $\xi = -0.95 \pm 0.3$. The muon polarization along the direction predicted by these values for ξ is +0.9 ± 0.1, in agreement with the value +1 required by theory. In a calibration experiment the muon longitudinal polarization in the decay $K^+ \rightarrow \mu^+ + \nu$ to be -1.0 ± 0.1 is found. This result is evidence of the adequacy of the technique, as the polarization is known to be -1. (Disser. Abstr.)

44589 A COMPLETE STUDY OF THE FORM FACTORS IN $K^+_{\mu 3}$ DECAY. Haidt, D. (Technische Hochschule, Aachen); Stein, J.; Natali, S.; (and others). Phys. Lett., 29B: 696-9(Aug. 18, 1969).

The validity of the V-A theory in $K^+_{\mu 3}$ decay is checked and the contribution of the tensor interaction is found to be compatible with zero. A consistent interpretation of measurements of the $K^+_{\mu 3}$ Dalitz plot density, of the muon polarization in $K^+_{\mu 3}$ decay, and of the $K^+_{\mu 3}/K^+_{e 3}$ branching ratio is found to be possible. From a study of the relative magnitude and four-momentum transfer dependence of the vector form factors, the best fit to the combined data is $\lambda_+ = 0.060^{+0.008}_{-0.011}$, $\Lambda = -0.01^{+0.03}_{-0.04}$, and $\xi(5m_\pi^2) = -0.93 \pm 0.23$. The results are compared to current theoretical predictions. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 43597, 44604, and 44660.

44590 (KFK-tr-287) INELASTIC (n,p) REACTIONS AT NEUTRON ENERGIES OF 2 TO 10 GeV. I. NEUTRON BEAMS, NEUTRON SPECTRA, AND REACTIONS WITH VARIOUS CROSS SECTIONS. Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR-P1-3909. 13p. (In German). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 22: 46323.

44591 $\bar{p}$ BACKWARD ELASTIC SCATTERING FROM 0.7 TO 2.16 GeV/c. Yoh, J. K. (California Inst. of Tech., Pasadena); Barish, B. C.; Nicholson, H.; (and others). Phys. Rev. Lett., 23: 506-10(Sept. 1, 1969).

Elastic scattering of $\bar{p}$ on p was studied for $\cos\theta_{cm}$ between -0.88 and -1.0 and $P_{lab}(\bar{p})$ between 0.70 and 2.16 GeV/c. The momentum dependence of the cross section shows a sharp dip at 0.9 GeV/c and a broad peaking around 1.4 GeV/c. The possibility of the peak resulting from direct formation of boson resonances was studied. Alternatively, a diffraction model agrees qualitatively with these data and other elastic data at different angles. (auth)

44592 A DETERMINATION OF THE BINDING ENERGY OF THE $_{\Lambda}{}^{13}$C HYPERNUCLEUS. Klabuhn, J. (Deutsche Akademie der Wissenschaften, Berlin); Krecker, U.; Coremans, G.; (and others). Nucl. Phys., B12: 336-40(1969).

From the observation of 11 examples of the π^- mesonic decay of $_{\Lambda}{}^{13}$C the binding energy of this hypernucleus is found to be 11.39 ± 0.15 MeV. (auth)

44593 DETAILED STRUCTURE OF THE REACTIONS IN $\bar{p}p \to \pi^+\pi^-$ AND $\bar{p}p \to K^+K^-$ FROM 0.7 TO 2.4 GeV/c. Nicholson, H. (California Inst. of Tech., Pasadena); Barish, B. C.; Pine, J.; (and others). Phys. Rev. Lett., 23: 603-6(Sept. 15, 1969).

Differential cross sections for the reactions $\bar{p}p \to \pi^+\pi^-$ and $\bar{p}p \to K^+K^-$ have been measured in the angular region $0.65 \lesssim |\cos\theta_{c.m.}| < 1.0$ at 13 momenta between 0.7 and 2.4 GeV/c. These cross sections have been combined with those of Fong et al. for $|\cos\theta_{c.m.}| \lesssim 0.70$ to give complete folded angular distributions. The data are consistent with resonances in the J = 3 and J = 5 states. (auth)

44594 STRUCTURE IN NEUTRON–PROTON CHARGE EXCHANGE. Mischke, R. E. (Princeton Univ., N. J.); Shepard, P. F.; Devlin, Thomas J. Phys. Rev. Lett., 23: 542-5(Sept. 8, 1969).

Neutron-proton charge-exchange differential cross sections for incident-neutron momenta between 600 and 2000 MeV/c show a sharp change in the slope of $d\sigma/dt$ vs $-u$ in the vicinity of $-u = 0.01$ (GeV/c)^2. Near the one-pion threshold the slope at $u = 0$ shows a maximum which reaches a value of order 100 (GeV/c)$^{-2}$. Also presented, as a function of s, is the intercept at $u = 0$ which shows a pronounced deviation from smoothness in the region above the inelastic threshold. (auth)

44595 ELASTIC p-d SCATTERING AT SMALL TRANSFER MOMENTA AT 1 GeV. Chernev, Kh. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 5-16(1969). (In Russian).

The elastic p-d scattering at 1 GeV in the region of four momentum transfer $0.003 < |t|\ (\text{GeV/c})^2 < 0.120$ was investigated. A total of 42,000 recoil deuterons were registered. The differential cross sections obtained in this experiment are given. According to Bethe, the results were analyzed, assuming the expressions for the nuclear scattering amplitude. The calculated values for the parameters are given. The experimental points and the fittest curve are shown. The total elastic scattering cross section in the range $1° < \vartheta < 30°$ was obtained. The ratio of the real to the imaginary parts of the scattering amplitude for p-d and p-n interactions at 1 GeV was found. The value obtained for α_{pn} in this experiment is in agreement with the dispersion relation prediction of Carter and Bugg. (auth)

44596 ZERO STRANGENESS RESONANCE PRODUCTION IN 6 GeV/c PROTON–PROTON COLLISIONS. Kinsey, Robert Ronald. Berkeley, Calif., Univ. of California, 1968. 138p. Thesis.

Approximately 33,000 four-pronged proton-proton interactions at 6 GeV/c were examined for the production of non-strange meson and baryon resonances. These events were found by scanning approximately 112,000 pictures taken in the LRL 72-in. hydrogen bubble chamber. The reactions studied in detail and their cross sections are (1) $pp \to pp\pi^+\pi^-$, 3.2 ± 0.3 mb; (2) $pp \to pn\pi^+\pi^+\pi^-$, 2.9 ± 0.4 mb; and (3) $pp \to pp\pi^+\pi^-\pi^0$, 2.4 ± 0.2 mb. (Disser. Abstr.)

44597 SINGLE PION PRODUCTION IN $\bar{p}p$ INTERACTIONS AT 2.7 GeV/c. Sears, R.; Socash, R.; Libby, L. Marshall (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Lett., 29B: 700-2(Aug. 18, 1969).

Single pion production is analyzed in unpolarized $\bar{p}p$ interactions at 2.7 GeV/c. Cross sections for channels $pp\pi^0$, $pn\pi^+$, and $np\pi^-$ are 2.67 ± 0.09 mb, 2.65 ± 0.09 mb, and 2.72 ± 0.09 mb respectively. A computation assuming one pion exchange does not reproduce the observed mass distributions. (auth)

44598 SCALING LAW FOR FAST PION PRODUCTION BY 20 TO 70 GeV PROTONS. Liland, A.; Pilkuhn, H. (Univ., Karlsruhe, Ger.). Phys. Lett., 29B: 663-5(Aug. 18, 1969).

Negative pion production with inelasticity >0.5 is shown to follow a simple scaling law. The law is used to predict π^+ and K^+ production by 70 GeV protons. For 300 GeV protons, it predicts fast pion intensities considerably smaller than those of the thermodynamic model. (auth)

Strong (Meson-Induced)

Refer also to abstract 43597.

44599 (BNL-13823) PROPERTIES OF THE Σ(1660) PRODUCED IN K^-p INTERACTIONS AT 3.9, 4.6, AND 5.0 GeV/c. Barnes, V. E.; Chung, S. U.; Eisner, R. L.; Flaminio, E.; Kinson, J. B.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.); Goldberg, M.; Jaeger, K. (Syracuse Univ., N. Y.). July 10, 1969. 23p. (CONF-690813-3). Dep. CFSTI.

From High Energy Physics Conference, Boulder, Colo.

The reaction $K^-p \to \Sigma^+(1660)\pi^-$ at 3.9, 4.6, and 5.0 GeV/c was studied. No evidence is found for the existence of a resonance near the Σ(1660) region, decaying primarily into $\Lambda\pi^+$ as reported previously. In particular, the Σ(1660) mass, width, and branching ratios are found to be consistent with the hypothesis of a single resonance being produced. However, the observed width of this resonance is approximately twice as large as that measured in formation experiments and in lower energy production experiments. Decay rates to $\Sigma\pi$, $\Lambda\pi$, $\Sigma(1385)\pi$, and NK are discussed. (auth)

44600 (COO-1428-141) PRODUCTION OF Λπ(1645) RESONANCE IN THE FINAL STATE $\Lambda\pi^+\pi^-\pi^-$ IN K^-d INTERACTIONS AT 4.5 GeV/c. Ammann, A. C.; Garfinkel, A. F.; Carmony, D. D.; Gutay, L. J.; Miller, D. H.; Yen, W. L. (Purdue Univ., Lafayette, Ind.). [1968]. 10p. (CONF-690813-1). Dep. CFSTI.

From High Energy Physics Conference, Boulder, Colo.

Evidence is presented for the production of a new Λπ resonance at a mass of 1645 MeV and a width of 50 MeV. $\Sigma^0\pi^+$ and K^-p decays of the state were searched for but not observed. (auth)

44601 π^+-p ELASTIC SCATTERING ON POLARIZED PROTONS AT LARGE MOMENTUM TRANSFERS. Conforto, G. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung., 26: 107-20 (1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Recent results of the measurements of π^+-p elastic scattering on polarized protons at large momentum transfers are reported and compared with Regge pole phenomenology. (auth)

44602 OBSERVATION OF "PERIPHERAL" BACKWARD MULTIPION PRODUCTION AT 2.15 GeV/c. Cline, D. (Univ. of Wisconsin, Madison); English, J.; Terrell, R.; Wilke, W.; Chaudhary, B.; Courant, H.; Marquit, E.; Ruddick, K. Phys. Rev. Lett., 23: 491-6(Sept. 1, 1969). (COO-881-253).

Using the Princeton–Pennsylvania Accelerator rapid-cycling bubble chamber in a flashlamp triggered mode backward $(\pi^+\pi^-)$ and $(\pi^+\pi^-\pi^0)$ multipion production were observed in the reaction $\pi^+n \to pm(\pi)$ at 2.15 GeV/c. The main characteristics of the data are a sharp forward peaking of the proton relative to the incident π^+ direction for all multipion masses below 1100 MeV/c and the strong production of the ω meson. Backward ω production is observed to be more probable than backward ρ production. The sharp forward peaking of the proton in these reactions is suggestive of the dominance of baryon exchange. (auth)

44603 MEASUREMENT OF RECOIL PROTON POLARIZATION AT 300 MeV MESON ELASTIC SCATTERING ON HYDROGEN. Vasilevskii, I. M.; Vishnyakov, V. V.; Tyapkin, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 115-20(July 1969). (In Russian).

The measurement of the recoil proton polarization in π^-p scattering at 300 MeV is described. A set up consisting of hodoscopic system of Geiger counters with controlled pulsed feeding and of a spark chamber is used in the experiment. The asymmetry in the recoil proton scattering on hydrogen nuclei was detected

by means of a spark chamber. 5191 events of the recoil proton scattering on hydrogen nuclei were registered. The analysing capacity of carbon on the beams of polarized protons with the energy 122, 136, and 146 MeV was experimentally studied to obtain the value of the recoil proton polarization in π^-p scattering. (auth)

44604 THE STRUCTURE OF THE ($\rho\pi$) DECAY OF THE A_2 MESON PRODUCED IN ANTIPROTON–PROTON ANNIHILATIONS AT 1.2 GeV/c. Donald, R. A.; Edwards, D. N.; Foster, M.; Moore, R. S. (Univ. of Liverpool). Nucl. Phys., B12: 325-35 (1969).

A re-analysis of previous data on pp annihilations of 1.2 GeV/c shows evidence of a split structure in the ($\rho\pi$) decay of the A_2 meson. The shape is compatible with the dipole formula with the mass and width found in the missing mass spectrometer experiments. (auth)

44605 EVIDENCE FOR A $\pi\eta$ RESONANCE AT 970 MeV PRODUCED IN $K^-p \to \Lambda\pi^+\pi^-$ MM AT 3.9, 4.6, AND 5.0 GeV/c. Barnes, V. E. (Brookhaven National Lab., Upton, N. Y.); Chung, S. U.; Eisner, R. L.; Flaminio, E.; Guidoni, P.; Kinson, J. B.; Samios, N. P.; Bassano, D.; Goldberg, M.; Jaeger, K. Phys. Rev. Lett., 23: 610-14(Sept. 15, 1969).

Evidence is presented for the existence of a boson resonance (δ) with $M = 970 \pm 15$ MeV and $\Gamma \leq 50$ MeV produced in the reaction $K^-p \to \Sigma^+(1385)\delta^-$, $\delta^- \to \pi^-\eta$. By studying the δ^- produced in association with $\Sigma^+(1385)$, we are able to rule out possible kinematic effects as a source of the enhancement in our data. We give upper limits to other decay modes such as 2π, 3π, and $K\bar{K}$. (auth)

44606 π^-p ELASTIC SCATTERING AT 2.51, 2.76, AND 3.01 GeV/c NEAR $t \simeq -3$ (GeV/c)^2. Fellinger, M. (Iowa State Univ., Ames); Gutman, E.; Lamb, R. C.; Peterson, F. C.; Schroeder, L. S.; Chase, R. C.; Coleman, E.; Rhoades, T. G. Phys. Rev. Lett., 23: 600-2(Sept. 15, 1969).

Differential cross sections for the elastic scattering of negative pions from hydrogen have been measured over a limited range of squared four-momentum transfer (t) in the vicinity of $t \simeq -3$ (GeV/c)^2 for incident pion momenta of 2.51, 2.76, and 3.01 GeV/c. These measurements confirm the existence of a minimum in the differential cross section in this region of incident momentum and scattering angle. The minimum occurs at a smaller value of t [$t \simeq -2.6$ (GeV/c)^2] than has been observed at higher momenta. (auth)

Particle Interactions and Properties (Theoretical)

General

44607 (IFVE-STF-68-68) ELASTIC AND NONELASTIC PROCESSES AT HIGH ENERGIES WITH SCATTERING, AT OREAR'S ANGLES, OF THE PARTICLES PRODUCED. Anisovich, V. V.; Khrustalev, O. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 38p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is supposed that at high energies: (1) the processes take place either peripherally or multiperipherally then at small momentum transfer $-t_i \lesssim 0.5$ GeV^2 the amplitudes fall as exp ($a_i t_i$) where a_i-some constants. Thus the unitary conditions in the S-channel give the following properties to the amplitudes with the Orear's transfer ($-t > 0.5 + 1$ GeV^2, $S \gg t$) (a) the amplitude of the process $A + B \to A + B$ falls as ($-6AB\sqrt{-t'}$), (b) the amplitude of charge exchange and backword scattering falls with the same $A + B \to C + A$ (c) in the same way the amplitude of the process falls with changing nonzero quantum number in the t-channel b-being min. (2) such multiperipheral processes with the Orear's transfer as $A + B \to a + b + c + \ldots$ are comparatively large. In the Orear's transfers the particles produced in the center-of-mass system are gathered along one direction their amplitude behavior is as exp ($-B_{AB}\sqrt{s/2}\,\Theta$) where Θ- is an ejection angle of the particles. (auth)

44608 ON THE INFINITE COMPONENT WAVE EQUATIONS. SOME PROBLEMS OF INTERPRETATION AND OUTLINE OF AN APPLICATION. Bisiacchi, G. (Univ., Trieste, Italy); Calucci, G.; Fronsdal, C. Acta Phys. Acad. Sci. Hung., 26: 21-4(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The form factors obtained in the study of the infinite components wave functions are compared with the ones obtained in a much more conventional way through the use of the Schrödinger equation. The classical problem like the elastic scattering of photons by a hydrogen atom is treated in detail. (auth)

44609 SUM RULES AND COVARIANCE. Montvay, I. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 26: 159-68(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

A representation of commutator matrix elements is derived in Lehmann–Symanzik–Zimmermann formalism and applied to current density algebra sum rules in an arbitrary frame of reference. The sum rules take a remarkably simple form if the current correlation functions obey multiple integral representations in the current masses. The reference frame dependence of the sum rules becomes explicit. (auth)

44610 REPRESENTATIONS OF AN ALGEBRA OF THE GELL-MANN–DASHEN TYPE. Havlicek, M. (Technical Univ., Prague). Commun. Math. Phys., 13: 78-80(1969).

Let G^∞ denote the infinite-dimensional Lie algebra given by commutation relations $[a^\alpha_m, a^\beta_n] = c^{\alpha\beta}_\gamma a^\gamma_{m+n}$ (m, n = 0, 1, ...), where $c^{\alpha\beta}_\gamma$ are structure constants of the arbitrary centerless Lie algebra. The construction of a certain class of skew-symmetric irreducible representations (so called F-representations) of the algebra G^∞ is considered. (auth)

44611 ON THE PARAMETRIZATION OF THE GENERALIZED VENEZIANO AMPLITUDE. Giovannini, A.; Gliozzi, F. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim., Lett., 2: 296-300(Sept. 1, 1969).

It is proven that there is a simple geometrical structure which reproduces all the algebraic properties of the u_{ij} variables conjugate to the Regge trajectories a_{ij} for the generalized Veneziano model for N external particles. (J.F.P.)

44612 SOME IMPLICATIONS FOR SCATTERING OF A SHORT-RANGE INTERACTION. Finley III, James Daniel. Berkeley, Calif., Univ. of California, 1968. 70p.

Thesis.

Possible characterizations of "short-range" interactions are investigated by means of conditions on the total transition probability, $||T\varphi||^2$. The characterizations fall into two types: those which are valid only for certain types of sequences of wave packets, and those which are valid for arbitrary wave packets. With respect to the first type, a criterion is developed for selecting "proper" wave packets and, for these wave packets, it is required that the total transition probability decrease exponentially as the displacement of the wave packet from the scattering center increases. It is then shown that for all such interactions what is essentially the square of the scattering amplitude is analytic, in the cosine of the scattering angle, in an ellipse which always includes the physical region. These results are then compared with Schroedinger potential theory and thereby the type of the exponential decrease of a potential is related to the type of the exponential decrease of the corresponding transition probability. Then the assumption is generalized on the transition probability so that it will apply to an arbitrary wave packet. This is done by utilizing a measure, $G[R, \varphi]$, of how much a wave packet, φ, is within a sphere of radius R about the scattering center, at all times. Then a "short-range" interaction is characterized by the existence of a positive constant A and positive functions B(p) and C(p) such that $||T\varphi||^2 \leq A\, G[R, \varphi] + \langle C(p)e^{-RB(p)}\rangle\ \varphi$, for all $R \geq 0$. It is then shown that for such interactions the square of the scattering amplitude is analytic, in the cosine of the scattering angle, in an ellipse the size of which depends upon B(p). Finally the results are compared with similar results previously obtained. (Disser. Abstr.)

Electromagnetic

Refer also to abstracts 44608 and 44646.

44613 (AD-687711) THE CORRECTION OF SCATTERED-ELECTRON SPECTRA FOR RADIATIVE EFFECTS. Crannell, Hall (Stanford Univ., Calif. High-Energy Physics Lab.). Jan. 1969. Contract Nonr-225(67). 25p. (HEPL-510). CFSTI.

The distortions caused by the effects of nuclear and thick-target bremsstrahlung on the spectrum of scattered electrons obscure the actual-elastic and inelastic cross sections. A method whereby the spectrum can be systematically corrected for these effects is presented. The method uses previous theoretical calculations of the radiative probabilities and employs an iterative technique for step by step correction of the spectrum. Uncertainties due to statistical errors in the measurement propagate through such a calculation. A formulation in which the uncertainties can be explicitly calculated is presented. Corrections to the calculations due to effects such as the change in cross section with change in

electron energy are discussed. Special problems associated with the applications of digital computers to this technique are described. (auth)

44614 (IC-69/85) RADIATIVE CORRECTIONS TO WEAK DECAYS INVOLVING LEPTONS. Riazuddin (International Centre for Theoretical Physics, Trieste (Italy)). July 1969. 50p. Dep. CFSTI (U. S. Sales Only).

The discussion of radiative corrections to leptonic weak decays concerns the computation of second order radiative corrections to first order weak interactions. The weak interactions are considered as local interactions of two currents. Radiative corrections to the beta decay of point-like particles and radiative corrections to $\Delta Y = 0$ and $\Delta Y = 1$ semileptonic processes are covered. (J.F.P.)

44615 ELECTROMAGNETIC MASS DIFFERENCES, EQUAL-TIME COMMUTATORS, AND OSCILLATING SPECTRAL FUNCTIONS. Sucher, J. (Univ. of Maryland, College Park). Acta Phys. Acad. Sci. Hung., 26: 153-8(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

A connection is suggested between the ambiguities in the definition of the equal-time commutator $[J_i^m(0,\vec{x}), J_\nu^m(0)]$ and the experimental indications of an exponentially falling electromagnetic form factor for the nucleon. On this basis, a resolution is proposed of the difficulty of current algebra models which appear to give divergent expressions for the electromagnetic mass shifts of hadrons. (auth)

44616 VENEZIANO REPRESENTATION FOR CHARGED-PION PHOTOPRODUCTION. Ahmad, M. (Univ. of Islamabad, Rawalpindi, Pakistan); Fayyazuddin; Riazuddin. Phys. Rev. Lett., 23: 504-6(Sept. 1, 1969).

It is shown that the forward peak in the differential cross section for positive-pion photoproduction can be explained with Veneziano representation for the appropriate amplitude. (auth)

44617 CALCULATION OF THE CHARACTERISTICS OF THE TRANSIENT RADIATION IN THE OPTIC REGION OF FREQUENCIES FOR DIFFERENT ELEMENTS IN THE ENERGY RANGE FROM $\gamma = 1.1$ TO $\gamma = 1000$. Yanikova, E.; Yanout, Z.; Lehar, F.; Pavlovic, P.; Zrelov, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 74: 61-9 (1969).

Basic characteristics of the transient radiation in the optic part of the spectrum for the elements Al, Ni, Cu, Ge, Ag, Pt, and Au have been calculated. In particular, the angular and spectral distributions of the photons have been calculated as well as their sum number emitted forward and backward. The calculation results for the particle energy range from $\gamma = 1.1$ to $\gamma = 1000$ are presented in tables. (auth)

44618 SIMPLE DERIVATION OF SCHWINGER'S QUANTIZATION RELATION BETWEEN ELECTRIC AND MAGNETIC CHARGES. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Nuovo Cim., Lett., 2: 221-2(Aug. 21, 1969).

A straightforward derivation of the Schwinger quantization relation is presented taking account of electron spin and the Pauli contribution to the quantization of electron orbits in a plane perpendicular to the magnetic field. (J.F.P.)

44619 SIMPLIFIED METHOD OF SIMULATING ELECTROMAGNETIC SHOWERS. Cioni, G.; Treves, A. (Univ., Milan. CNR, Milan). Nuovo Cim., 62B: 371-8(Aug. 11, 1969).

A Monte Carlo program for studying electromagnetic showers is described. The main difference with previous programs is its simplicity which is obtained by using in certain parts experimental data. The distribution of track length in a small-dimension absorber of lead glass is calculated for electrons of energy between 50 and 500 MeV. The output of a Cherenkov counter is then studied theoretically and the results are compared with experiments. (auth)

44620 FIXED POLES IN PHOTOPRODUCTION OF CHARGED PIONS. Bender, I.; Dosch, H. G.; Rothe, H. J. (Univ., Heidelberg). Nuovo Cim., 62A: 1026-37(Aug. 21, 1969).

Two fixed Khuri poles, suggested by field-theoretical models, as well as two Regge poles (A_2 and B) are used in order to interpret π^+ and π^- photoproduction off nucleons. In the framework of this model the (evasive) pion is not Reggeized. The model, involving only four free parameters, is found to be in good agreement with the experimental data for photon energies above 8 GeV. (auth)

44621 APPLICATION OF LOGARITHMIC NORMAL DISTRIBUTION TO THE ANALYSIS OF EXPERIMENTAL DATA ON EXTENSIVE AIR SHOWERS. Kalmykov, N. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 10: 121-9(July 1969). (In Russian).

Assuming that the associate distribution of the electron number N_e, muon number N_μ and the s-parameter for the shower with fixed primary energy may be represented as multidimensional Gaussian distribution in variables $\ln N_e$, $\ln N_\mu$ and s, the parameters of the two-dimensional distributions for showers with fixed values of N_e and N_μ are found. The effect of experimental errors on the distributions is considered. The role of fluctuations is analyzed while taking the spectrum on the number of particles instead of the energy spectrum of the primary radiation. (auth)

44622 CUT CONSPIRACY AND K EVASION IN $K^+\Lambda$ PHOTOPRODUCTION AT HIGH ENERGIES. Froeyland, Jan (Univ., Oslo). Nucl. Phys., B12: 410-14(1969).

It is shown that a model only involving a conspiring KP cut and an evading K trajectory gives a reasonable fit to the $K^+\Lambda$ photoproduction data for γ-ray energies from 5.0 to 16.0 GeV in the lab system. (auth)

44623 VACUUM POLARIZATION EFFECTS IN e^+e^- ANNIHILATION. Cremmer, E.; Gourdin, M. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., B12: 383-94(1969).

The modifications of the photon propagator due to mesons are computed in the light of recent e^+e^- annihilation experiments and the effect on $e^+e^- \to \pi^+\pi^-$ and $e^+e^- \to K^0\bar{K}^0$ is estimated. (auth)

44624 NON-REGGE BEHAVIOUR IN THE REACTION $\gamma + p \to \pi^- + N^{*++}$. Bender, I.; Dosch, H. G.; Rothe, H. J. (Univ., Heidelberg). Nuovo Cim., 63A: 162-6(Sept. 1, 1969).

Fixed poles are used to describe the reaction $\gamma p \to \pi^- N^{*++}$ for photon laboratory energies larger than 5 GeV. Good agreement with the available experimental data is obtained for all measured energies and momentum transfers. (auth)

44625 MODEL FOR PHOTONS AND GRAVITONS BASED ON BROKEN SYMMETRY. Ohanian, Hans C. Princeton, N. J., Princeton Univ., 1968. 131p.

Thesis.

A dynamical model is presented in which photons and gravitons are regarded as Goldstone bosons associated with a breakdown of Lorentz symmetry. Such a model of the photon has been constructed by Bjorken (electrodynamics of a spinor field) and by Guralnik (electrodynamics of a scalar field). A detailed discussion is given of both the spinor and scalar cases. The construction of the model for the linear approximation to gravitation follows a similar plan. (Disser. Abstr.)

44626 HIGH-ENERGY BEHAVIOR OF ELECTRON–POSITRON ANNIHILATION CROSS-SECTION. Hayot, F. (State Univ. of New York, Stony Brook); Nieh, H. T. Contract AT(30-1)-3668B. Phys. Lett., 29B: 689-90(Aug. 18, 1969).

By a simple counter example it is demonstrated that the asymptotic behavior of the total cross-section for electron-positron annihilation into hadrons, $q^2\sigma^{(h)}(-q^2) \to$ const., as $-q^2 \to \infty$, which was obtained by a number of authors for a quark-like fermion model, is not a necessary consequence of the quark model. (auth)

44627 LOW-ENERGY THEOREMS FOR MESON PRODUCTION BY REAL AND VIRTUAL PHOTONS. Kalet, Ira Joseph. Princeton, N. J., Princeton Univ., 1968. 89p.

Thesis.

The crossing matrix for photoproduction of pions from nucleons is studied to discover the kinematic singularity and kinematic zero structure of photoproduction helicity amplitudes. Unsubtracted dispersion relations are then formulated for two of the s-channel amplitudes and all four t-channel amplitudes, with the one-partial state contributions computed from unitarity and explicitly displayed. This representation is used to derive the Kroll–Ruderman theorem for threshold photomeson production, and certain constraint conditions on the terms of next order in the meson momentum. A helicity formalism for virtual photons is developed and the aforementioned technique used to derive a threshold theorem for electroproduction of pions. Sum rules are formulated for photoproduction and electroproduction amplitudes and a limited attempt is made to test the photoproduction sum rules. Derivations are given, using field-theoretic techniques, of a threshold theorem for vector meson photoproduction and an extension of the Kroll–Ruderman theorem to pion photoproduction on arbitrary spin targets. (Disser. Abstr.)

44628 APPLICATIONS OF THE LORENTZ GROUP TO REGGE POLE ANALYSIS OF PION PHOTOPRODUCTION. Dash, Jan William. Berkeley, Calif., Univ. of California, 1968. 70p.

Thesis.

Applications of Lorentz invariance and Regge pole theory to the phenomenological study of photoproduction of pions from nucleons and nucleon-nucleon scattering are considered. First the kinematics for the more general cases having all unequal and

nonzero external masses are worked out, and then the limit of equal baryon masses and zero photon mass is taken. Then the applications of Lorentz symmetry at t = 0 (i.e., conspiracy) are considered, and the photoproduction daughter sequence is explicitly obtained through analyticity arguments. The factorization of the photoproduction Regge residues is shown to be consistent with the conspiracy relations in the nucleon-nucleon and pion Compton scattering processes. Finally, high energy pion photoproduction data along with nucleon-nucleon data are analyzed assuming the existence of an M = 1 pion parity doublet conspiracy. The consequences of assuming a square-root type zero or a full zero in the $\pi N\bar{N}$ vertex function are investigated. The possibility of the existence of an M = 1 B − ρ' parity doublet conspiracy is investigated qualitatively through a photoproduction sum rule for the photon isoscalar amplitude, and by requiring consistency between phenomenological fits. Additional experimental tests for an M = 1 B trajectory are proposed. (Disser. Abstr.)

44629 POMERANCHUK-POLE EXCHANGE CONTRIBUTION TO FORWARD PHOTON PROCESSES. Ebata, T.; Lassila, K. E. (Ames Lab., Iowa). Nuovo Cim., Lett., 2: 284-7(Aug. 21, 1969).

It is shown that an appropriate generalization of gauge invariance as a requirement following from Lorentz invariance of the S-matrix can lead to modifications in the kinematical factors of the helicity amplitude in such a way that the Pomeranchuk Regge pole exchange can contribute to forward Compton scattering. (J.F.P.)

Weak

Refer also to abstracts 44586 and 44688.

44630 (NYO-3399-202) ALGEBRAIC MODELS FOR WEAK INTERACTIONS. Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). July 1969. 11p. (SU-1206-202; CONF-690607-3). Dep. CFSTI.

From International Conference on Quark Models and Symmetry, Detroit, Mich.

Three distinct but correlated algebraic models for hadron semileptonic weak interactions are discussed. These concern nuclear beta decay and semileptonic meson and baryon decay. Relations are established with strong and electromagnetic interactions, and some predictions are obtained which agree with many experimental results. (J.F.P.)

44631 REVIEW OF CURRENT ALGEBRA RESULTS IN THE WEAK DECAYS OF THE METASTABLE HADRONS. Kunszt, Z.; Nagy, T. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 26: 191-9(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Without claiming completeness the main achievements in the applications of the current algebraic approach to weak decays are surveyed. (auth)

44632 PROBLEMS OF THE THEORY OF WEAK INTERACTIONS. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Acta Phys. Acad. Sci. Hung., 26: 201-4(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

It is not a theorem that no conventional theory of weak interactions exists. (auth)

44633 K_{l3} FORM FACTORS, CURRENT ALGEBRA, AND DOUBLE INTEGRAL REPRESENTATIONS. Montvay, I. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 26: 169-77(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Predictions of current algebra for the K_{l3} form factors are considered using double integral representations of the current correlation functions. The K_{l3} form factor parameters ξ, λ_z and the mass and width of the $\varkappa = K(0^+)$ meson are calculated in good agreement with currently known experimental values. (auth)

44634 A DIFFICULTY IN SELLERI'S THEORY OF WEAK INTERACTIONS. McDonald, A.; Rosen, S. P. (Univ. of Sussex, Brighton, Eng.). Nuovo Cim., Lett., 2: 207-8(Aug. 11, 1969).

It is pointed out that Selleri's theory of weak interactions in which angular momentum is not conserved does not provide a natural explanation for the observed branching ratio $\pi \to e + \nu$ to $\pi \to \mu + \nu$. (L.B.S.)

44635 PARAMETERS OF THE PHENOMENOLOGICAL THEORY OF K_L^0 DECAY. da Silveira, A. (NEPEC, Santa Tereza, Brazil). Nuovo Cim., Lett., 2: 194-8(Aug. 11, 1969).

Relations between the parameters η_{00}, η_{+-}, and ϵ of the phenomenological theory of K decay are examined by taking into account the real part of A_2/A_0, where A_2 and A_0 are respectively the I = 2 and I = 0 amplitudes of $K^0 \to \pi + \pi$. (L.B.S.)

44636 ON THE CHARGE ASYMMETRY IN $K_L \to \pi^+\pi^-\pi^0$. McCliment, E. R. (Univ. of Iowa, Iowa City); Teeters, W. D. Nuovo Cim., 62A: 949-60(Aug. 21, 1969).

Analysis of the decay $K_L \to \pi^+\pi^-\pi^0$ suggests that additional information in the form of the CP violation can be obtained by a more sensitive measurement of the charge asymmetry. In particular, we show that if the current-current interaction has validity and the once-integrated commutation relations hold, then one can check whether $\epsilon' \ll \epsilon$ independently of the relation $|\eta_{+-}| \simeq |\eta_{00}|$. (auth)

44637 FORM FACTORS FOR LEPTONIC DECAYS OF BARYONS. Ioffe, M. V. (Leningrad State Univ.). Yadern. Fiz., 10: 144-7(July 1969). (In Russian).

Form factors for leptonic decays of baryons are calculated in the first order on the momentum transfer squared. In the infinite momentum frame the current algebra commutation relations are saturated with the $\frac{1}{2}^+$ baryons and $\frac{3}{2}^+$ baryon resonances. Correction to the result, due to the SU(3)-symmetry violation in the strong interaction Hamiltonian, is estimated qualitatively. (auth)

44638 ON EXCLUSION OF ONE TYPE OF NONEXPONENTIALITY FOR K^0-MESON DECAYS. Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 139-43(July 1969). (In Russian).

It is shown that the existence of asymmetry in K^0-meson leptonic decays at far distances from the target allows one to exclude for K^0 meson the nonexponentiality of the type considered by Goldberger and Watson. Unitarity relations and some general properties of quasi-stable states are discussed. (auth)

44639 A MODEL OF NONMESONIC DECAYS OF HYPERNUCLEI WITH A DIRECT TRANSITION OF Λ HYPERON INTO NEUTRON. Filimonov, V. A.; Potashev, A. G. (Tomsk Polytechnic Inst., USSR). Yadern. Fiz., 10: 130-8(July 1969). (In Russian).

A model is presented for nonmesonic decays of hypernuclei that differs from the commonly accepted stimulating model. The nonmesonic decay of a hypernucleus proceeds by means of a direct transition of the Λ hyperon into neutron. The effective weak two-baryon interaction transforming Λ into n is taken the same as in the pole models of nonleptonic and radiative decays of hyperons. Probabilities of the two-body decays ${}^4_\Lambda H \to tn$, ${}^4_\Lambda He \to {}^3He\ n$, ${}^4_\Lambda He \to \alpha n$ and of all the nonmesonic decays of these hypernuclei are calculated by means of the presented model. The calculated probabilities are in agreement with the experimental data. (auth)

44640 SLOW DEPOLARIZATION OF μ^+ MESONS IN SOME SUBSTANCES. Minaichev, E. V.; Myasishcheva, G. G.; Obukhov, Yu. V.; Roganov, V. S.; Savel'ev, G. I.; Firsov, V. G. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 421-31(Aug. 1969). (In Russian).

Data indicating the presence of "microsecond" μ^+ meson depolarization mechanisms in B_4C, LiF and other substances are obtained by observing the time distribution of $\mu^+ \to e^+ + \nu + \bar{\nu}$ decays in transverse and longitudinal magnetic fields. The effect of temperature and aggregate state of matter on the phenomenon is investigated. It is shown that microsecond depolarization can be removed by a longitudinal magnetic field $H \lesssim 200$ Oe. The possibilities of differentiating between "rapid" and "slow" depolarization stages from the viewpoint of the muon theory of depolarization of μ^+ mesons in matter are analyzed. (auth)

44641 WEAK DECAYS OF THE METASTABLE HADRONS. Kunszt, Z.; Nagy, T. (Roland Eoetvoes Univ., Budapest). Fortschr. Phys., 17: 73-128(1969).

The weak decay of metastable $J^P = \frac{1}{2}^+$ baryons and $J^P = 0^-$ mesons is reviewed. The experimental selection rules for the weak Hamiltonian and the conclusions for the structure of the weak Hamiltonian from these rules, current algebra results and radiative corrections, and the phenomenological analysis of the CP-violating effects and the experimental situation regarding these effects are discussed. (J.F.P.)

Strong (General)

44642 (UCLA-34-P-106-38) UCLA PARTICLE PHYSICS RESEARCH GROUP ANNUAL PROGRESS REPORT. (California Univ., Los Angeles. Dept. of Physics). June 1, 1969. Contract AT(11-1)-34. 35p. Dep. CFSTI.

Research at UCLA from June 1, 1968 to May 31, 1969 on π + p and n + p interactions is described. Also the PDP-5, PDP-8/1 data acquisition system and the calibration of a scintillation counter array for the detection of neutrons are described. (J.F.P.)

44643 PROCEEDINGS OF THE SYMPOSIUM ON HADRON SPECTROSCOPY, KESZTHELY, HUNGARY, 6–11 SEPTEMBER, 1968. Acta Phys. Acad. Sci. Hung., 26: 1-223(1968). (CONF-680927).

Twenty-eight papers are included; a separate abstract was prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 44601, 44608, 44609, 44615, 44631–44633, 44647–44649, 44658, 44659, 44673, 44688, 44693–44697, 44706, 44707, and 44727–44733.

44644 HIGH-ENERGY RELATIONS FOR SCATTERING OF PARTICLES AND ANTIPARTICLES. Mickens, R. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nuovo Cim., Lett., 2: 231-5(Aug. 21, 1969).

The consequences of analyticity in energy and crossing for scattering amplitudes of particles and antiparticles are discussed. The results are generalized to high-energy two-body scattering of strongly interacting particles with arbitrary spins. Pomeranchuk theorems are proven for various cross sections and polarizations. (J.F.P.)

Strong (Baryon No. = 0)

44645 MASSIVE GAUGE FIELDS AND ASSOCIATED PSEUDOSCALAR MESONS. Finkelstein, R.; Staunton, L. (Univ. of California, Los Angeles). Ann. Phys. (N. Y.), 54: 97-121(Aug. 1969).

The massive gauge field, either free or coupled to a massless fermion field, is shown to be the Lagrangian equivalent of a composite massless field containing pseudoscalar as well as vector components. These fields are minimally coupled to each other while the pseudoscalar part has no direct fermion interaction (vector dominance). In general the total boson field consists of both vector and pseudoscalar components, but there exists a privileged gauge in which the pseudoscalar components are transformed away. The vector field in this special gauge is formally identical to the pseudoscalar current in the general gauge; therefore the field algebra in the privileged gauge is identical to the current algebra in the general gauge. That is, vector fields go into pseudoscalar currents under a local gauge transformation. In the formalism the pseudoscalar field plays the role of a coordinate system on the group space while the vector field correlates the group space at distinct space-time points. The nonlinear Lagrangian may be expressed in terms of geometric invariants of the group space and is manifestly invariant under general transformations of the pseudoscalar field. (auth)

44646 CORRECTIONS TO THE GELL–MANN–SHARP–WAGNER MODEL FOR THE MESON DECAYS $\omega \to 3\pi$, $\omega \to \pi\gamma$, $\pi \to \gamma\gamma$. Epifanov, Yu. N.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.). 9: 366-9(May 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 601-5(May 20, 1969).

The corrections to the GSW model for the decays $\omega \to 3\pi$, $\omega \to \pi\gamma$, and $\pi^0 \to 2\gamma$, resulting from the departure of the virtual particles from the mass shell, are calculated. (L.B.S.)

44647 S-MATRIX THEORY OF PION–PION SCATTERING. Graves-Morris, P. R. (Univ. of Kent, Eng.). Acta Phys. Acad. Sci. Hung., 26: 95-9(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

A one parameter model of the pion–pion scattering amplitude is given, which satisfies crossing symmetry and unitarity approximately. The results are qualitatively correct. (auth)

44648 FINITE ENERGY SUM RULES FOR MESON–MESON SCATTERING. Costa, G.; Savoy, C. A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Acta Phys. Acad. Sci. Hung., 26: 89-90(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Finite energy sum rules, based on analyticity properties of scattering amplitudes, are applied to meson–meson scattering. (auth)

44649 THE $A_1\rho\pi$ SYSTEM. Csikor, F. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 26: 179-80(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The current algebra calculations of the $A_1\rho\pi$ system are reviewed and results of different methods are compared. (auth)

44650 CROSSING-SYMMETRIC INTERFERENCE MODEL AND THE $A_1\rho\pi$ SYSTEM. Aly, H. H.; Fayyazuddin; Moffat, J. W. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., Lett., 2: 327-30(Sept. 1, 1969).

The $A_1\rho\pi$ system in the interactions $\pi^+ + \pi^- \to \pi^- + A_1$ is considered in the framework of the crossing-symmetric Regge-pole interference model. (J.F.P.)

44651 ON THE SCATTERING AMPLITUDE $A(\bar{p}n \to 3\pi)$. Boldrighini, C.; Pugliese, A. (Univ., Rome). Nuovo Cim., Lett., 2: 239-42(Aug. 21, 1969).

The phenomenological consequences of the amplitude $F(s,t) = \{[\Gamma(1-\alpha(s))/\gamma\,\Gamma(1-\alpha(t)/\gamma)]/[\beta\,\Gamma(1-(\alpha(s)+\alpha(t))/\gamma]\}$ for the process $\bar{p} + n \to 3\pi$ are considered. It is concluded that the discrepancy with experimental data reflects the insufficiency of the amplitude studied. (J.F.P.)

44652 COMPARISON OF THE VENEZIANO AMPLITUDE WITH CHIRAL DYNAMICS FOR MESON–MESON SCATTERING. Murtaza, G.; Harun-ar Rashid, A. M. (Univ. of Islamabad, Rawalpindi, Pakistan). Nuovo Cim., Lett., 2: 189-93(Aug. 11, 1969).

It was previously shown that the ρ width obtained from the Veneziano formula is smaller than the one obtained from current algebra calculations. The amplitude for $\pi\pi$ and πK scattering is examined in the context of chiral dynamics and it is found that the Veneziano amplitude is compatible with that obtained from the chiral Lagrangian. The two models were found to give the same ρ width. (L.B.S.)

44653 SUPERCONVERGENT SUM RULES FOR PION–PION SCATTERING. Wanders, G. (Univ., Lausanne, Switzerland). Nuovo Cim., 63A: 108-28(Sept. 1, 1969).

Sum rules for pion-pion scattering amplitudes are derived using analyticity, crossing symmetry and rigorous or ad hoc asymptotic bounds. They are superconvergent in the sense that they involve only integrals over physical quantities. They differ from the simplest superconvergent relations because absorptive parts as well as derivatives of absorptive parts with respect to the momentum transfer appear in the integrals. The fact that one of the sum rules is likely to be violated provides an experimental evidence for the necessity of subtractions. Our present information on pion-pion scattering (known resonances and high-energy behavior as predicted by the Regge-pole model) is in qualitative agreement with the sum rules. They are used for setting the orders of magnitude of some pion-pion parameters. (auth)

44654 NOTE ON THE CURRENT ALGEBRA CALCULATION OF THE $\pi\pi$ SCATTERING LENGTHS. Ghika, G.; Radescu, E. E.; Visinescu, M. M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 215-18(1969).

A treatment of the on-shell $\pi\pi$ scattering lengths is given considering that an important contribution comes from Z graphs and should be taken into account. Previously neglected corrections are also treated. The on-shell scattering lengths were found considering that there is no appreciable $\pi\pi$ interaction. The threshold region off-shell corrections are expressed in terms of the $\pi\pi$ scattering lengths in a model independent way and in terms of a Z graph contribution. (J.F.P.)

44655 INTERFERENCE EFFECTS IN THE MULTIPERIPHERAL MODEL. Tuan, R. Hong (Ecole Polytechnique, Paris). Nuovo Cim., Lett., 2: 271-4(Aug. 21, 1969).

Some results of an investigation of a correlation effect consisting in an apparent attraction of mesons (π) of like charge and in a repulsion of unlike mesons (π) are given. The multiperipheral model is used to study this correlation effect, and it is treated as an interference effect. Possible modification of a previous model was sought which could account for this correlation effect in $\bar{p} + p \to 3\pi^+ + 3\pi^-$ interactions at 1.2 GeV/c with production of the ρ resonance. It is found that both the resonance production and the predominant P-wave production of the pion pairs near threshold are necessary for the studied correlation effect. Doubts arise concerning a previous parameterization where the factors in the multiperipheral model behave as constants when the relative momentum of neighbor pions in the multiperipheral diagram tend to zero. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 44601, 44685, and 44739.

44656 (COO-1428-142) THE δ_0^1 PHASE SHIFT AT LOW $\pi\pi$ MASSES. Scharenguivel, J. H.; Meiere, F. T. (Purdue Univ., Lafayette, Ind.). July 1969. 15p. (CONF-690813-2). Dep. CFSTI.

From High Energy Physics Conference, Boulder, Colo.

The forward-backward asymmetry α, for $\pi\pi$ masses $\sqrt{s} < 0.6$ GeV, was parametrized as a function of s and Δ^2, where Δ^2 is the squared four-momentum transfer. A relativistic effective range

formula was used for δ_1^1 and δ_0^2. The δ_0^2 phase shift has been determined from the values of α at the pion pole, $\Delta^2 = -\mu^2$. (auth)

44657 (IS-T-291) AN APPLICATION OF REGGE THEORY AND SU(3) REPRESENTATION MIXING TO HIGH ENERGY REACTIONS SUGGESTING A SECOND A_2 MESON. Austin, Donald Murray (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 90p. Dep. CFSTI.

Thesis.

A mixing formalism for scalar fields carrying representations of SU(3) is developed in a field-theoretic framework and extended to boson fields with spin. This formalism is applied to the twin-peaked A_2 mass distribution by assuming the existence of an isovector meson multiplet belonging to the 27-dimensional representation of SU(3) which is mixed with the usual tensor octet isovector A_2 in a manner such that the double peak occurs for some decay modes while a single peak may occur for others. Good fits to all of the relevant data are obtained. This theory is then Reggeized and used to fit the high energy cross section data for eta production by pions. An "averaged" fit to the direct channel resonance structure in the total cross section data is obtained by extrapolating the Regge amplitudes to the low energy region. Also, the Regge trajectories obtained from this calculation are shown to be in agreement with those required to explain the forward peak in pion photoproduction. The consequences of the duality hypothesis for an inelastic reaction are examined by partial wave analyzing the Regge amplitudes for eta pion-production. The Argand diagrams plotted from the resulting partial wave amplitudes are seen to represent families of direct channel resonances. These are compared to the resonance structure obtained from a similar analysis of π-N elastic scattering and to the low energy data. (auth)

44658 π-N RESONANCE WIDTHS IN THE BROKEN SL(2,C) MODEL. Szego, K.; Toth, K. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 26: 57-63(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The elastic decay width of some πN resonances is evaluated in the the SL(2,C) model of Regge poles. Two families of resonances are examined in the first order of symmetry breaking, one of them has isotopic spin $I = \frac{1}{2}$, the other $I = \frac{3}{2}$. The width of other resonances along the trajectories is calculated in symmetry limit and the differential cross section is examined for πN backward scattering. The results are in good agreement with experiments. (auth)

44659 INTRODUCTION TO CHIRAL SYMMETRY AND NON-LINEAR LAGRANGIANS. Nauenberg, M. (Univ. of California, Santa Cruz). Acta Phys. Acad. Sci. Hung., 26: 121-5(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The nonlinear realization of the approximate chiral symmetry of the strong interactions is presented. (auth)

44660 POSSIBLE RISING TRAJECTORIES IN THE pp SYSTEM. Graffi, S. (Univ., Bologna); Grecchi, V.; Turchetti, G. Nuovo Cim., Lett., 2: 311-17(Sept. 1, 1969).

The $p + p \rightarrow \pi^+ + d$ system is investigated for possible rising trajectories. Various experimental results are discussed concerning this effect. Also the Orear-Krisch parametrization of the forward cross section is discussed. (J.F.P.)

44661 COMMENTS ON A POSSIBLE OVERLAP OF t AND u EXCHANGES IN K$\mathcal{N}$ BACKWARD SCATTERING AT INTERMEDIATE ENERGIES. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nuovo Cim., Lett., 2: 307-10(Sept. 1, 1969).

Experimental evidence is reviewed and discussed to discover evidence of an overlap of t and u exchanges in K$\mathcal{N}$ backward scattering at 1.5 to 4 GeV/c. It is pointed out that a decisive experimental test that can differentiate between a direct-channel resonance and t-channel exchange interpretation of the observed K^+p structure will come through the study of $K^+n \rightarrow K^0p$ interactions at 180°. (J.F.P.)

44662 PION-NUCLEON CHARGE-EXCHANGE SCATTERING IN THE ABSORPTION MODEL. Siddique, M. H.; Enz, C. P. (Geneva Univ.). Nuovo Cim., 63A: 261-8(Sept. 1, 1969).

The $\pi^-p \rightarrow \pi^0n$ process is studied from 5.9 to 18.2 GeV/c with a modified absorption model. The agreement with experiment for differential cross-sections is good in the small-momentum-transfer region. Predictions are made with respect to the polarization of the final neutron. (auth)

44663 ACCOUNT OF SPIN OF INTERACTING PARTICLES IN INELASTIC PROCESSES AT HIGH ENERGY. Kudryavtsev, V. A.; Levin, E. M.; Shchipakin, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 10: 148-64(July 1969). (In Russian).

The problem of the effect of the particle spin on the three-particle production amplitude in the region where all the pair energies are high is discussed. Some consequences for definite reactions are given. (auth)

44664 VENEZIANO MODEL FOR K$\mathcal{N}$ SCATTERING. Igi, K.; Storrow, J. K. (CERN, Geneva). Nuovo Cim., 62A: 972-82 (Aug. 21, 1969).

A Veneziano-type model for kaon-nucleon scattering is shown to give a reasonable approximation to nature as regards: elastic widths of the Y* trajectories, forward scattering and backward scattering at high energies. (auth)

44665 ON A NEW KIND OF SOLUTIONS FOR THE CHEW-LOW TYPE EQUATIONS. Zhuravlev, V. I.; Meshcheryakov, V. A.; Rerikh, K. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 168-75(July 1969). (In Russian).

It is shown that for the crossing matrix of the third order A (1,1) there exist solutions of a new kind with the property that at least one of the ratios $S_1(w)/S_j(w)$ possesses an infinite number of poles in the plane of the uniforming variable w. Properties of the constructed solutions are discussed. (auth)

44666 CHARGE-EXCHANGE SCATTERING AND REGGE CUTS. Krzywicki, A.; Tran Thanh Van, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., Lett., 2: 249-55(Aug. 21, 1969).

Some asymptotic relations between observable quantities for charge-exchange reactions are derived, although no attempt is made to fit existing experimental data. The relations studied depend on rather general properties of the Regge cuts suggested by the study of the analytic S-matrix and by experience with phenomenological models. The polarization is found for the charge-exchange scattering of pseudoscalar octet particles. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 44732.

44667 (CERN-69-10) MULTIPLE COULOMB SCATTERING AT SMALL ANGLES OF HIGH-ENERGY PARTICLES IN LIMITED AREAS, APPLICATIONS. Durand, Alain (Rennes Univ. (France). Faculte des Sciences). May 13, 1969. 134p. (In French). Dep.

General methods are determined for studying multiple scattering of particles at high energies in a limited area in the small angle approximation when the Fermi equation can apply. These methods are applied to problems of scattering by a plane or by a right angle, and the angular and spacial distributions are determined taking account of energy losses or a possible transverse magnetic field. Examples are given of meson (π) scattering at 450 MeV/c by aluminum or iron. These results can be used for calculating the rejection rate of a multiplate separator and the scattering of undesirable particles by the plates of this separator. The K-π rate of rejection for separation by a multiplate separator is calculated. (J.F.P.)

44668 (IC-69/87) QUASIPOTENTIAL THEORY OF HIGH-ENERGY HADRON SCATTERING. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A.; Tavkhelidze, A. N. (International Centre for Theoretical Physics, Trieste (Italy)). Aug. 1969. 35p. Dep. CFSTI (U. S. Sales Only).

The methods and some applications of the quasipotential description for p + p elastic and inelastic scattering at high energies are presented. The simplest nonsingular quasipotential of the Gaussian form which is purely imaginary is considered. Spin complications, mass differences, etc. are ignored. The comparison with experiment is found to be good. It is concluded that the quasipotential equation is effective for high-energy hadron scattering studies. (J.F.P.)

44669 (INP-678) HIGH ENERGY COLLISIONS OF HADRONS AND NUCLEI. Czyz, W. (Institute of Nuclear Physics, Krakow (Poland)). Mar. 1969. 36p. (CONF-690421-1). Dep. CFSTI (U. S. Sales Only).

From Conference on the European Physical Society, Florence, Italy.

Applicability of the high energy scattering model of strongly interacting composite particles to nuclear and hadronic scattering is discussed using the examples of π-d, p-^{16}O and p-p high energy elastic scattering. (auth)

44670 VACUUM POLARIZATION INTERACTION BETWEEN PROTONS, EFFECTIVE RANGE PARAMETERS, AND TRIPLET PHASES. Brolley, J. E. (Los Alamos Scientific Lab., N. Mex.). Aust. J. Phys., 22: 327-35(June 1969).

The scattering cross section is formulated in terms of the Coulomb, vacuum polarization, and nuclear amplitudes. Com-

parison is made with available data; the search variables being the effective range parameters and a strength factor Λ for the vacuum polarization, as well as two triplet parameters. The strength factor Λ attained the value 0.92 at optimum fit and new values of the effective range parameters are obtained. Scattering experiments are suggested that should have appreciable sensitivity to the vacuum polarization amplitude. Estimates of the triplet phases and spin polarization are given. (auth) (Australia)

44671 DETERMINATION OF THE NUCLEON–NUCLEON SCATTERING MATRIX. X. (p,p) AND (n,p) ANALYSIS FROM 1 TO 450 MeV. MacGregor, Malcolm H.; Arndt, Richard A.; Wright, Robert M. (Univ. of California, Livermore). Phys. Rev., 182: 1714-28(June 25, 1969).

Energy-dependent and energy-independent phase-shift analyses are given for (p,p) and (n,p) experiments from 0.5 to 450 MeV. The 2066 data include 1076 (p,p) and 990 (n,p) values. The theoretical analysis has been extended to include magnetic-moment corrections, separate $^1S_0$ phases for (p,p) and (n,p) scattering, S-wave vacuum-polarization effects, and inelastic effects due to pion production with isotopic spin I = 1 (down to threshold). Precision fits to the data are obtained over the whole energy range. The least-squares sum χ^2 is 1126 for a 26-parameter energy-dependent fit to the (p,p) data. The M value is 1.046. The value for the pion-nucleon coupling constant obtained from this solution is $g^2 = 14.43 \pm 0.41$. The I = 1 scattering matrix is quite accurately and uniquely determined over the whole energy range. Two 26-parameter energy-dependent solutions are given for the fit to the (n,p) data. The first solution (unconstrained) has somewhat anomalous values for ϵ_1 and $^1P_1$ at low energies. The second solution has a constraint that forces ϵ_1 to positive values at low energies. When this is done, the $^1P_1$ phase also changes to values expected from theory. The values of χ^2 (M) from the (n,p) data for these two solutions are 1100 (1.11) and 1138 (1.15), respectively; thus both solutions are statistically acceptable. The (n,p) solution at 425 MeV has been greatly improved by the addition of precise triple-scattering data from the Chicago-Wisconsin group. Comparison of energy-dependent and energy-independent solutions shows that the I = 0 scattering matrix is fairly accurately determined at 142, 210, and 425 MeV, but at 25, 50, 95, and 330 MeV the solution is not definitive, because of a lack of (n,p) data. Measurement of the ratio $\sigma(180°)/\sigma(90°)$ for (n,p) scattering at 25 or 50 MeV to an accuracy of 1% would help to remove the ambiguity in the ϵ_1 and $^1P_1$ phases. The use of a separate $^1S_0$ phase for (n,p) scattering eliminated the difficulty in fitting to (n,p) total cross sections below 100 MeV, and especially at very low energies. The addition of S-wave vacuum-polarization effects permitted a precision fit to the lowest-energy (p,p) differential-cross-section data. The combined (p,p) plus (n,p) 1–450-MeV energy-dependent solution, with 52 parameters representing 27 elastic phases and one inelastic phase, has $\chi^2 = 2226$ for 2066 data. The M value is 1.077. (auth)

44672 MULTIPLE SCATTERING, HADRON'S STRUCTURE, AND HIGH ENERGY PHENOMENA. Fleming, H. (Univ., Turin); Giovannini, A.; Predazzi, E. Ann. Phys. (N. Y.), 54: 62-96(Aug. 1969).

The approach to discuss high energy physics is taken of first deriving a phenomenological formula fitting p-p elastic data at high energy over the whole angular interval and then discussing its mathematical properties and its physical implications in connection with some of the usual models used to describe high energy phenomena. Although several ambiguities are inherently present in this approach, arguments are given to suggest that the underlying physical mechanism may be attributed to a multiple scattering process of increasingly large order with increasing energy or, equivalently, to the effect of infinitely many diffractivelike potentials corresponding to inner and inner regions of interaction. The resulting picture visualizes the proton as a composite object whose number of constituents increases with energy or, equivalently, as an onion-like structure with an increasingly large number of layers. The connection of the approach with a statistical model interpretation are also briefly discussed since it appears that a statistical-like and a diffractive-like formulation of the problem can be made compatible one with the other in the sense that they reduce one to the other under a well defined mathematical process. (auth)

44673 ON THE DECOUPLET SUPERCONVERGENCE RELATIONS FOR MESON–BARYON SCATTERING. Kwiecinski, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Acad. Sci. Hung., 26: 91-3(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The possible superconvergence relations which correspond to the decouplet exchange in the t-channel were considered for meson–baryon scattering. It was found that superconvergence relations hold for non-spin-flip but fail for the spin-flip amplitudes. It is suggested that the failure of the latter may be due to the j-plane branch point singularity which protects the fixed singularity at the wrong signature nonsense point j = 0. (auth)

44674 PION SCATTERING OFF DEUTERON WITH LARGE MOMENTUM TRANSFER TO NEUTRON. Gurvits, S. A.; Marinov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 10: 165-7(July 1969). (In Russian).

The reaction $\pi d \to pn\pi$ is considered at high energies in the case when the pion momentum is transferred to the neutron. It is shown that the observed cross section differs from that for the πn scatterings in a few per cent of its value, provided only the events with slow protons are taken. (auth)

44675 ON THE PROCESS $NN \to NN\pi$ NEAR THRESHOLD. Baier, R.; Kuehnelt, H. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., 63A: 135-40(Sept. 1, 1969).

Pion threshold production in nucleon–nucleon collisions is studied by two different approaches. After giving a new and simple derivation of the Adler–Dothan theorem we calculate π^0 production. The results are comparable to other calculations. Then we use the effective-Lagrangian method and get agreement with experiment for π^0 production. The cross section for $pn \to pp\pi^-$ is too high by a factor of 3 ÷ 4. (auth)

44676 COHERENT ELASTIC SCATTERING OF π-MESONS FROM DEUTERIUM: THEORY AND APPLICATIONS. Alberi, G. (Univ., Trieste, Italy); Bertocchi, L. Nuovo Cim., 63A: 285-314 (Sept. 1, 1969).

The Glauber theory is extended to include spin variables for πD scattering. The results are compared with existing experiments and rather good fits are obtained. Predictions for forthcoming experiments are given. The possibility of extracting the phase of πN amplitude from polarization experiments is briefly discussed. (auth)

44677 HIGH-ENERGY PROTON–PROTON SCATTERING IN THE EIKONAL MODEL. Capella, A.; Kaplan, J.; Krzywicki, A.; Schiff, D. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 63A: 141-61(Sept. 1, 1969).

The eikonal model for high-energy pp scattering is extended to include spin effects. The single scattering corresponds to the exchange of a flat Pomeranchukon and two (degenerate) secondary trajectories. A very simple parameterization with five arbitrary parameters is chosen. A good description of the pp data on total and differential cross-sections, the ratio of real to imaginary part of the amplitude at t = 0 and polarizations is obtained, for incident momenta between 5 and 20 GeV/c. Predictions for the $p\bar{p}$ high-energy scattering are made. They are in reasonable agreement with the experimental data and exhibit the cross-over effect near the right value of the momentum transfer. Some general features of the eikonal model are also discussed. (auth)

44678 STOPPING POWER AND RANGE FOR ANY NUCLEUS IN THE SPECIFIC ENERGY INTERVAL 0.01- TO 500-MeV/amu IN ANY NONGASEOUS MATERIAL. Steward, Palmer Gilbert. Berkeley, Calif., Univ. of California, 1968. 173p.

Thesis.

A method is presented for calculating range and stopping-power data for any heavy ion with $0.01 \leq \epsilon \leq 500$ MeV/amu incident upon any nongaseous stopping medium. The method is incorporated into a FORTRAN IV computer program. Results for H, ^{4}He, ^{12}C, ^{20}Ne, ^{40}Ar, ^{84}Kr, ^{131}Xe, and ^{222}Rn ions each incident upon H_2O, Al, Cu, Ag, Pb, and U are presented. For ions at low energy with $Z \leq 10$, the program uses experimental data. For ions with Z > 10, the nuclear and electronic stopping-power theory developed by Lindhard et al., is adjusted to fission-product range data at low energy; for intermediate-energies, charge-state data developed from experimental Ar range-energy data in Al are extended to other ions and stopping media. Bethe's theory is used for all ions at high energy. Bloch's theory is discussed, although it is not used in the method. The particle ranges calculated by the method are pathlength ranges and do not include the effects of multiple scattering. A method for calculating projected range at low energies is presented. (Disser. Abstr.)

44679 VARIATIONAL BOUNDS IN NEUTRON–DEUTERON SCATTERING. Carew, John F. New York, New York Univ., 1968. 70p.

Thesis.

A study of the scattering states of the three-nucleon system is undertaken. Using the equations of Faddeev a variational bound formulation of the scattering problem is given. This approach differs from previous variational bound principles in that the projection operators of Feshbach do not appear. In this formulation

a two body Lippmann–Schwinger equation for the reaction matrix is derived in which variational parameters appear in the effective potential. Each solution to this equation is a variational bound on the true reaction matrix. This equation is applied to the neutron-deuteron system and solved on a computer for various choices of the variational parameters. Local central potentials with Gaussian radial form are employed. In the quartet state the results found are in agreement with previous calculations. However, in the doublet state the solution is strongly dependent on the variational parameters and the best results differ appreciably from previous calculations and with experiment (phase shifts actually differ in sign). (Disser. Abstr.)

44680 LAMBDA–NUCLEON INTERACTION. Deloff, A. (Inst. for Nuclear Research, Warsaw). Fortschr. Phys., 17: 129-66(1969).

Theoretical aspects of the Λ + N interactions are reviewed. The topics covered include experimental evidence for the Λ + N interaction, the Λ – N scattering matrix and phenomenological analysis, and forces including SU(3) symmetry and the generalized Pauli principle, theoretical discussion of the Λ – N forces, and charge symmetry breaking effects in the Λ – N interactions. Also models are considered including the phenomenological potential, the Brueckner–Watson TPE potential, and the one-meson-exchange model. (J.F.P.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 44737.

44681 (IFVE-STF-68-75) UNITARY IRREDUCIBLE REPRESENTATIONS OF THE DE-SITTER GROUP O(2,3). [PART] II. Leznov, A. N.; Fedoseev, I. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

All the irreducible representations of the group SO(2,3) which possess the invariant hermitian form are found. Also an explicit expression is given for this form for all the cases. (auth)

44682 (IS-T-303) HYPERPLANE FORMALISM AND ITS APPLICATION TO THE THEORY OF ELEMENTARY PARTICLES. McDonald, Stanley Clifton (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 72p. Dep. CFSTI.

Thesis.

The principle of covariance as applied to the theory of elementary particles is further exploited by extending Fleming's hyperplane formalism to include a discussion of the operations of the Poincaré group as seen by an arbitrary hyperplane observer. The hyperplane generalization of the infinitesimal generators of the connected part of the Poincaré group are constructed by performing a Lorentz transformation on the canonical generators, and are seen to be those operators previously defined by Fleming. Helicity basis states for the $m^2 > 0$ irreducible representations of the Poincaré group are re-expressed within the framework of generalized covariance provided by the hyperplane formalism, and are seen to be related to the conventional helicity states of Jacob and Wick by a special Lorentz transformation. In a similar fashion, the canonical states constructed by Foldy are generalized to an arbitrary hyperplane. The localized states of Newton and Wigner are reconstructed as a superposition of the canonical states, and these states are also generalized to an arbitrary hyperplane via a procedure similar to that used for the hyperplane generalization of the helicity and canonical states. The corresponding position operator, with mutually commuting components, is then constructed, and is seen to be equivalent to that operator given by Fleming. (auth)

44683 THE GROUP F_4 AND ITS GENERATORS. Wadzinski, H. T. (John Hopkins Univ., Baltimore). Nuovo Cim., 62B: 247-57(Aug. 11, 1969).

The representations of F_4 are discussed and the decompositions of some representations in the reductions $SO_{26} \rightarrow F_4 \rightarrow SO_9$ are tabulated. The decompositions of some inner products of F_4 are also tabulated. A general method of constructing operator bases for representations of larger groups is given. Using this method, operators corresponding to the generators of F_4 acting on the representation (1000) are constructed. This method also generates relations between 6-j symbols and some examples are given. (auth)

44684 POLYNOMIAL BASES FOR THE IRREDUCIBLE REPRESENTATIONS OF SU(4). Jakimow, George. Montreal, McGill Univ., 1968.

Thesis.

The unitary unimodular group in four dimensions (SU(4)) in the SU(4) ⊃ SU(3) ⊃ SU(2) chain is considered. Generators are expressed by differential operators acting on states represented by functions of fourteen independent variables. Orthonormal bases in the form of polynomials for irreducible representations (characterized by λ, μ, ν) are constructed in a simple way. The method parallels that used previously to find polynomial bases of O(5). First, bases of (λ,0,0), (0,μ,0), (0,0,ν) are formed, then (λ,μ,0), and finally (λ,μ,ν). The (λ,μ,0) and (λ,μ,ν) bases are expressed as linear combinations of products of (λ,0,0), (0,μ,0) and (λ,μ,0), (0,0,ν) states, respectively. The coefficients, special stretched SU(4) Clebsch–Gordan coefficients, are found by using two differential conditions. These conditions ensure the absence of unwanted states, i.e., states belonging to lower representations. Matrix elements of the generators are then derived explicitly. General bases formed by coupling (λ,0,ν) with (0,μ,0) states are envisaged and the degeneracy problem is discussed. (Disser. Abstr.)

44685 TEST FOR TOLLER POLES. Feldman, G.; Matthews, P. T. (Imperial Coll. of Science and Tech., London). Phys. Rev. Lett., 23: 548-51(Sept. 8, 1969).

The Treiman–Yang analysis is extended to test the validity of the O(3,1) expansion of a two-body scattering amplitude and related to the M value of a Toller pole. (auth)

44686 ON A COMPLETE SET OF COMMUTING OPERATORS FOR GROUP O(n). Nikolov, A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 29-35(1969). (In Russian).

An investigation of the Casimir operators for the group O(n), begun previously, is continued. A basic system of the independent Casimir operators is isolated and a complete set of commuting operators is constructed. (auth)

44687 THE CASIMIR OPERATORS FOR GROUP O(n). Nikolov, A. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 17-27 (1969). (In Russian).

A method of finding the eigenvalues of the Casimir operators of an arbitrary order for the group O(n) is developed; the formulas defining the irreducible representations of O(n) obtained by Gel'fand and Zetlin are used. The suggested method essentially differs (due to the specific features of the above-mentioned formulas) from that applied by Perelomov and Popov for the same purpose. The results essentially differ as well (the definitions of the Casimir operators are different); the result obtained is more effective. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 44641.

44688 A MODEL OF MAXIMAL CP VIOLATION. Okubo, S. (Univ. of Rochester, N. Y.). Acta Phys. Acad. Sci. Hung., 26: 205-15(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

A model of weak interaction is introduced which shows maximal CP violation. The model contains an octet (or nonet) of intermediate vector meson fields with a strong tri-linear self-coupling. First order terms are forbidden, while second order terms give CP = 1, third order terms CP = −1 effects. The smallness of CP-violating effects is thus easily explained. (auth)

44689 NEW LIMIT ON T INVARIANCE IN $K^0 \rightarrow 2\pi$. Achiman, Y. (Tel Aviv Univ., Israel). Nuovo Cim., Lett., 2: 301-6(Sept. 1, 1969).

It is shown that using the unitary sum rule for K^0 decays and the world average for ϕ_+, the lower bound on $|\eta_{00}/\eta_+|$ due to T conservation may be raised considerably. In particular if the new value for ϕ_{00} is also used it is clear that T is violated. (J.F.P.)

44690 POSSIBLE RELATION BETWEEN LEPTON NONCONSERVATION AND CP NONCONSERVATION. Primakoff, H.; Sharp, D. H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 23: 501-3(Sept. 1, 1969).

A weak-interaction Hamiltonian is presented which can account in a unified way for the CP nonconservation observed in K_L decay and for a possible lepton nonconservation associated with nuclear double-beta decay. (auth)

44691 TEST OF CPT INVARIANCE. Wolfenstein, L. (Carnegie-Mellon Univ., Pittsburgh). Nuovo Cim., 63A: 269-78 (Sept. 1, 1969).

It is pointed out that severe limits on CPT noninvariance exist from the data on $K^0 \rightarrow 2\pi$ decay only if the CPT-violating inter-

action is parity-conserving. CP-violating and strangeness-conserving. The limits on and tests of CPT noninvariance for the cases of other symmetry properties of the CPT-violating interaction are discussed. The phenomenology of $K \to 2\pi$ decays and $K \to \pi l \nu$ decays with CPT violation is given. (auth)

Applications (Strong)

Refer also to abstracts 44637, 44658, and 44659.

44692 (PPAR-22) POSSIBLE ADDITIONAL TESTS OF CHARGE CONJUGATION INVARIANCE IN OTHER THAN WEAK INTERACTIONS. Barshay, Saul (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Aug. 13, 1969. Contract AT(30-1)-2137. 13p. Dep. CFSTI.

The possible near degeneracy in mass of recently detected massive neutral boson states with opposite charge conjugation allows for the possibility that a relatively weak C-violating interaction is enhanced in mixing these states. Some observable C-violating effects that are a consequence of this mixing are discussed. (auth)

44693 IMPLICATIONS OF THE O(4,2) MODEL OF STRONG INTERACTIONS FOR REGGE POLE AND HIGH-ENERGY PHENOMENOLOGY. Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy). Acta Phys. Acad. Sci. Hung., 26: 5-19(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Linear Regge trajectories, secondary trajectories, form factors and their relation to high-energy hadron scattering are consequences of the O(4,2) model of strong interactions. The O(4), O(2,1) and the two distinct SL(2,C) classifications of trajectories used at present, as well as the exchange degenerate trajectories, are all given by the subalgebras of the O(4,2). (auth)

44694 GROUP THEORETICAL DESCRIPTION OF RELATIVISTIC SCATTERING NEAR ZERO MOMENTUM TRANSFER. Suranyi, P. (Central Research Inst. for Physics, Budapest). Acta Phys. Acad. Sci. Hung., 26: 25-34(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The behavior of scattering amplitudes is investigated near zero momentum transfer. The contribution of Lorentz poles to high energy scattering is studied. The theoretical considerations are compared with experimental results on resonance data. (auth)

44695 GENERALIZED CHIRAL SYMMETRY GROUPS AND THE CLASSIFICATION OF HADRONS. Guersey, F. (Middle East Tech. Univ., Ankara). Acta Phys. Acad. Sci. Hung., 26: 127-37(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The existence of Lagrangian models partially invariant under groups that generalize chiral symmetry is shown. The implications of these models with regard to the classification of hadrons are discussed. The currents defined from the Lagrangian satisfy a current algebra which includes tensor currents and provides a generalization of the usual SU(3) ⊗ SU(3) current algebra with the extension of the PCAC condition to the more general currents. (auth)

44696 NON-LINEAR LAGRANGIANS AND RELATIVISTIC SU(6). Welling, D. (Univ. of Wisconsin, Milwaukee). Acta Phys. Acad. Sci. Hung., 26: 139-46(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

A method for constructing a phenomenological nonlinear Lagrangian of the hadrons within the relativistic framework is presented. A particular SL(6,C)-invariant series of meson–meson and meson–baryon interactions are introduced and it is shown that in a first-order calculation a relation between the various couplings is possible if PCAC is maintained. Using the coupling constant for $\rho\pi\pi$ as input the following results are noted: $\Gamma(X^0 \to \eta\pi\pi) = 2$ MeV, $\Gamma(\omega \to 3\pi) = 8.9$ MeV, $g^2_{NN\rho}/4\pi = 0.54$. (auth)

44697 CURRENT DIVERGENCES IN THE $SU_3 \times SU_3$ ALGEBRA. Renner, B. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.). Acta Phys. Acad. Sci. Hung., 26: 147-52(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary See CONF-680927.

The scheme of the charge-current equal time commutators for an octet of vector currents and axial-vector currents implying an $SU_3 \times SU_3$ algebra generated by the charges is extended to commutators of charges with current divergences. (auth)

44698 A DERIVATION OF GELL-MANN'S c PARAMETER. Kloet, W. H.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim., Lett., 2: 228-30(Aug. 21, 1969).

The SU(3) × SU(3) symmetry breaking term in the hadron energy density of the form $H' = -u_0 - cu_8$ is considered. The value of the c parameter is determined by using the $\pi\pi \to \pi\pi$ amplitude and PCAC only for the pions. (J.F.P.)

44699 O(3,1) SYMMETRY AND THE BEHAVIOR OF THE AMPLITUDES FOR $p + \pi \to p + \pi$ PROCESS AT HIGH ENERGY. Palev, Cavdar; Samiullah, M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 43-6(1969).

The high-energy behavior of the invariant amplitudes at $t = 0$ in the DSS formalism were computed for $\pi + p \to \pi + p$ interactions on the basis of a single Lorentz pole exchange model in the cross channel. The method used allows the determination of the behavior of only A and D amplitudes from previous work and is in complete agreement with those findings. (J.F.P.)

44700 MASS FORMULAE IN THE LADDER REPRESENTATIONS OF GROUP U(6,6). Nikolov, Angel. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 37-41(1969).

Baryons and mesons at rest are described by ladder representations, but the mass operator is determined in a different way. It is assumed that baryons and mesons form infinite multiplets. The ladder representations of the group U(6,6) were used for baryon and meson mass formulas. (J.F.P.)

Field Theories

General

44701 (AD-686058) GRAVITY AND ELECTRIC CHARGE. Physical Sciences Research Papers No. 363. Leiby, C. C. Jr. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Nov. 1968. 32p. (AFCRL-68-581). CFSTI.

The many similarities between gravitational and electromagnetic fields suggest that they may be characterized by a single (super) source function. A complex vector source is found to yield the correct interaction strengths (the scalar products of these vectors) for the classical inverse-square law forces between electrically charged masses. The real vector component has the magnitude of the coulomb charge of the body. The magnitude of the imaginary vector component is given by the mass of the body renormalized in units of charge. Complex vector charges (CVC), for the classical electron, proton, and neutron are developed. Appropriate sums of these vectors represent the atoms. Substitution of CVC for coulomb (scalar) charge in Maxwell's equations generates two separable sets of equations: the real component set, characterizing electromagnetic fields; and the imaginary component set, characterizing gravitational fields. The imaginary electric field represents the Newtonian gravitational field, whereas the imaginary magnetic field results in motional gravitational forces similar to those found in general relativity theory. Such forces would result in the gradual alignment of planetary orbits and spins. Acceleration of CVC generates (classical) complex radiation fields, that is, positive-energy photons and negative-energy gravitons. Thus conservation of energy requires that all charge-neutral, finite inertial rest mass particles possess non-vanishing electromagnetic moments. Extension to a nonclassical theory that can include both atomic and nuclear binding energies is suggested. (auth) (USGRDR)

44702 GEOMETRICAL THEOREM ON THE ASYMPTOTIC SPACE–TIME PROPERTIES OF CONSERVATION LAWS IN A CLASSICAL FIELD THEORY. Cawley, Robert G. (Naval Ordnance Lab., Silver Spring, Md.). Ann. Phys. (N. Y.), 54: 122-48(Aug. 1969).

A result, having to do with the asymptotic space-time properties of conservations laws and which is called the cone bands theorem, is proved for a classical field theory model. With the aid of the theorem it is possible to define a tensor reduction procedure on conserved and asymptotically conserved quantities. The reduction procedure applied to such objects permits identification of components of radiation by means of conical hypersurfaces, or in analogy to particle world lines, radiation world cones, whose axes lie along the four velocities U_μ of the radiation. It is shown that for the classical theory of a massive real scalar field (retarded solution), produced by a collection of point sources experiencing arbitrary accelerations in a finite region of space-time, these conditions are met by the stress-energy tensor $T_{\mu\nu}$ and by a set of asymptotically conserved amplitude vectors $A^{(2)}_\mu(x)$. A dimensionless quantity $d^2N(U)$ arises which measures the amount of radiation lying along the direction U_μ and which is identified with the radiated particle number, or particle "number-probability." Because the cone bands property possesses a physical interpreta-

tion which is rooted in measurement procedures, it is noted that a necessary requirement on a classical field theory, for a particle interpretation to be meaningful in the asymptotic region is that all asymptotically conserved quantities which are regarded as being carried along by the particles possess the cone bands property. Relationship of the present work to quantum field theory is discussed. (auth)

44703 REPRESENTATION OF THE POINCARE GROUP IN E(2) BASIS. Novozhilov, Yu. V.; Prokhvatilov, E. V. (Leningrad State Univ.). Yadern. Fiz., 10: 193-7(July 1969). (In Russian).

Expressions for generators of unitary representations of the Poincare group in E(2) basis are obtained. The transformation function relating the canonical basis to the E(2) basis is found. Current matrix elements in the infinite momentum frame get a simpler form in the E(2) basis. (auth)

Quantum Field Theory

Refer also to abstracts 44645 and 44668.

44704 PARAMETRIC INTEGRAL REPRESENTATIONS OF RENORMALIZED FEYNMAN AMPLITUDES. Appelquist, Thomas (Cornell Univ., Ithaca, N. Y. Stanford Linear Accelerator Center, Calif.). Ann. Phys. (N. Y.), 54: 27-61(Aug. 1969).

A parametric integral representation for the amplitudes of renormalized perturbation theory is developed. The result is a closed, well-defined and unique renormalized amplitude to be associated with an arbitrary Feynman graph. By unique it is meant that the renormalized amplitude is explicitly independent of the initial choice of independent integration momenta and the routing of external momenta through the graph. The prescription is applicable to conventionally unrenormalizable as well as renormalizable theories. It is shown that for renormalizable theories, our representation is formally equivalent to the usual recursive subtraction formula for writing renormalized amplitudes and hence can be interpreted in terms of mass and coupling constant renormalization. To investigate the practical advantages of this formalism, a calculation of the fourth order vacuum polarization in quantum electrodynamics is carried out. (auth)

44705 RADIATION OF CLASSICAL SCALAR FIELDS FROM A POINT SOURCE: $m \to 0$ LIMIT OF MASSIVE THEORY vs. $m = 0$ THEORY. Cawley, Robert G. (Naval Ordnance Lab., Silver Spring, Md.). Ann. Phys. (N. Y.), 54: 149-63(Aug. 1969).

Radiation of a massive classical scalar field from a point source is studied in the mass zero limit and compared with the radiation emitted in a mass zero theory. The total radiated energy momentum is the same in both theories, but the rate cannot be got in the massive theory. The massive theory admits a particle number-probability interpretation, and a speed distribution and energy distribution can be found. The energy distribution goes like $\omega^{-(2n+1)}$ at high energies, the value of n depending on smoothness properties of the source world line. In the low ω region it is proportional to ω^{-1} until $(\omega - m)/m \ll 1$, where a strong suppression factor proportional to V^2 dominates. But despite this fact the radiated number diverges like $\log m^{-1}$ owing to contributions from particles with energies $O(m^0)$ but with ultrarelativistic speeds. Other interesting features have to do with speed distribution properties in the $m \to 0$ case. (auth)

44706 FIELD OPERATOR FOR AN INTERACTING UNSTABLE ELEMENTARY SYSTEM. Lukierski, J. (Univ., Wroclaw). Acta Phys. Acad. Sci. Hung., 26: 217-21(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The field operator $\varphi|; \alpha (x; s)$, describing an interacting unstable elementary system is introduced. Asymptotic fields are represented by free fields with continuous additional parameters. Consistency with the Haag–Ruelle theory of asymptotic states is achieved. (auth)

44707 EQUAL-TIME BEHAVIOUR OF CURRENT COMMUTATORS IN PERTURBATION THEORY. Kaschluhn, F.; Wieczorek, E.; Zoellner, W. (Humboldt Univ., Berlin. Forschungsstelle fuer Physik Hoher Energien, Berlin). Acta Phys. Acad. Sci. Hung., 26: 181-9(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The singular equal-time behavior of the vacuum expectation value of current commutators is determined for a field-theoretic model in second order perturbation theory. Using the well-known properties of the Wightman functions involved and relations for generalized functions studied in detail by Gelfand and Shilov it is shown in an unambiguous way that a gradient term appears whose coefficient has the singular behavior P/z_3^3 and $\log |z_3|$ with respect to the relative time (the first term is also found in second order quantum electrodynamics). The relation to the T-product of currents is investigated and defined within a special class of test functions. Furthermore, it is shown that the divergence of the T-product of conserved vector currents is localized in the sense of quasi-local operators involving arbitrary renormalization constants. (auth)

44708 FIELDS, OBSERVABLES, AND GAUGE TRANSFORMATIONS. I. Doplicher, Sergio (Univ., Aix-Marseille); Haag, Rudolf; Roberts, John E. Commun. Math. Phys., 13: 1-23 (1969).

Starting from an algebra of fields F and a compact gauge group of the first kind G, the observable algebra U is defined as the gauge invariant part of F. A gauge group of the first kind is shown to be automatically compact if the scattering states are complete and the mass and spin multiplets have finite multiplicity. Under reasonable assumptions about the structure of F it is shown that the inequivalent irreducible representations of U ("sectors") which occur are in one-to-one correspondence with the inequivalent irreducible representations of G and that all of them are "strongly locally equivalent." An irreducible representation of U satisfies the duality property only if the sector corresponds to a one-dimensional representation of G. If G is Abelian the sectors are connected to each other by localized automorphisms. (auth)

44709 SYMPLECTIC APPROACH TO THE THEORY OF QUANTIZED FIELDS. I. Garcia, P. L.; Perez-Rendon, A. (Univ., Barcelona). Commun. Math. Phys., 13: 24-44(1969).

The aim for the discussion of problems of field quantization starting from the symplectic structure underlying the classical theory, is to build up the variational theory necessary to all further constructions. The basic notions are the vertical bundle $\overline{B}$ and the structure 1-form θ used to define the generalized infinitesimal contact transformation which allows one to state and solve the variational problem related to field physics. Giving a system of module-valued differential forms of different degree on the vertical bundle whose solutions are the stationary cross sections is the main result. In this scheme the Euler–Lagrange classical equations are the expressions induced by such a system of differential forms on any cross section of the vertical bundle. This gives us a complete linearization of the Euler–Lagrange equations and, starting from it, a natural globalization of these equations. Finally, the notion of the variational problem invariant by a Lie group is defined in this scheme. Noether's theorem related to such invariant problem is formulated and an intrinsic version of the so-called Noether invariants of classical variational calculus is obtained. (auth)

44710 UNIQUENESS OF THE HAMILTONIAN IN QUANTUM FIELD THEORIES. Parrott, Stephen (Univ. of Massachusetts, Boston). Commun. Math. Phys., 13: 68-72(1969).

In most quantum field theories, one defines the Hamiltonian (energy) operator H as a limit of "cutoff" operators H_s: $H = \lim_{s\to\infty} H_s$. (The operator H_s would be the correct Hamiltonian for a world in which all momenta are smaller than s.) Since the cutoff operators seldom converge in any of the standard operator topologies, it is often necessary to invent more subtle notions of "convergence." For some of these, it is not obvious that the "limit" operator H is unique. It is pointed out that for one such method of obtaining convergence, the "limit" operator is not unique. In fact, (under mild assumptions about the operators H_s), if H_s converges to H, then H_s also converges to $H + R$, where R is an arbitrary bounded positive operator. (auth)

44711 SOLUTION OF THE DIRAC EQUATION IN ORTHOGONAL ELECTRIC AND MAGNETIC FIELDS. Canuto, V.; Chiuderi, C. (Goddard Space Flight Center, New York). Nuovo Cim., Lett., 2: 223-7(Aug. 21, 1969).

A further solution of the Dirac equation in external electromagnetic fields is derived in the case of constant electric and magnetic fields orthogonal to each other. (J.F.P.)

44712 A NEW EXPERIMENTAL TEST OF SPECIAL RELATIVITY. Shamir, J.; Fox, R. (Technion-Israel Inst. of Tech., Haifa). Nuovo Cim., 62B: 258-64(Aug. 11, 1969).

Although the special theory of relativity is almost generally accepted as a verified theory, existing experiments cannot distinguish it from a number of other rival theories that assume the existence of a preferred frame of reference (ether), and physical Lorentz contractions. It is shown that the Michelson–Morley experiment, performed in a solid transparent medium, is capable of such a distinction. The negative result of this experiment enhances the experimental basis of special relativity. (auth)

44713 RENORMALIZATION IN SPECTRAL FORM. Rohrlich, F. (Syracuse Univ., N. Y.). Nuovo Cim., Lett., 2: 199-202(Aug. 11, 1969).

The advantages of a method of renormalization for self-energy-type diagrams of standard quantum field theory are pointed out. It is shown by example that the method leads to the spectral representation form of the renormalized propagators. (L.B.S.)

44714 FUNCTIONAL FORMALISM IN QUANTUM FIELD THEORY. Dubois-Violette, M. (Faculte des Sciences, Orsay, France). Nuovo Cim., 62B: 235-46(Aug. 11, 1969).

A formalism is developed to deal with c-number generating functionals of quantum field theory. The general unitary relations and Schwinger equations are investigated using this formalism. Then, the formalism is used to construct a functional formulation of quantum field theory, in which state vectors are described by functionals, and field operators by functional differential operators. This formulation is in complete analogy with the wave-mechanics formulation of nonrelativistic quantum theory, in which state vectors are described by functions and observables by differential operators. Finally the case of the electromagnetic field is investigated. This framework leads to some unification of the functional formalism and simplifies the explicit calculations in many cases. (auth)

44715 INVARIANT DECOMPOSITION FOR SOLUTION OF THE DIRAC EQUATION. Agamaliev, A. K.; Atakishiev, N. M.; Verdiev, I. A. (Inst. of Physics, Baku). Yadern. Fiz., 10: 187-92 (July 1969). (In Russian).

Invariant decomposition for solution of the Dirac equation is obtained. It is shown that in the nonrelativistic limit the complete set of functions on the hyperboloid is reduced to the set of functions in the three-dimensional space. (auth)

44716 EXPANDING WAVEFRONTS IN SPECIAL RELATIVITY: A COMPUTER-GENERATED FILM. Schey, Harry M. (Massachusetts Inst. of Tech., Cambridge). Amer. J. Phys., 37: 514-19 (May 1969).

A computer-generated film is described which shows an expanding wave front as seen from a coordinate frame relative to which the source moves with constant velocity. An expression for the wave front as a function of time is derived, and features of it are discussed in terms of the relativistic laws for the additions of velocities. Sample stills from the film are presented and used in discussing the shape of the wave front, the velocity of the center of the wave front, and the headlight effect, all as functions of the signal velocity and the velocity of the source. (auth)

44717 REST MASS IN SPECIAL RELATIVITY. Leibovitz, C. (Tel-Aviv Univ., Israel). Amer. J. Phys., 37: 834-5(Aug. 1969).

Proper attention should be given in the teaching of special relativity to the relation between the rest mass and the potential field in all cases. The case of a scalar potential is considered. (auth)

Gravitation and General Relativity

Refer also to abstracts 44142, 44573, and 44625.

44718 (IC-69/80) CURVATURE COLLINEATIONS FOR GRAVITATIONAL pp-WAVES. Aichelburg, P. C. (International Centre for Theoretical Physics, Trieste (Italy)). Aug. 1969. 18p. Dep. CFSTI (U. S. Sales Only).

Vacuum fields which admit a covariant constant vector are investigated in order to find "curvature collineations," i.e., $\pounds R^{i}_{klj} = 0$. For all discussed types of pp-waves it is shown that proper curvature collineations exist. The explicit form of these transformations is stated. (auth)

44719 NEWMAN-PENROSE APPROACH TO TWISTING DEGENERATE METRICS. Talbot, C. J. (Univ. of Bradford, Eng.). Commun. Math. Phys., 13: 45-61(1969).

The well-known method of Newman and Penrose is used to find solutions of the Einstein empty space field equations, which are algebraically special and where the degenerate principal null vectors are not hypersurface orthogonal. As is to be expected the method systematically yields the results obtained by Kerr. An explanation is given of the complex coordinate transformation technique of generating new metrics from Schwarzschild's; also a generalization of Kerr and Schild type metrics is investigated. (auth)

44720 CRITIQUE OF RELATIVITY. Sepetys, Jonas. New York, Philosophical Library, Inc., 1968. 64p. $3.50.

The discussion of relativity theory covers the origin of the relativity theory, the Einstein concept of space and time, and the nature of space and time. (J.F.P.)

44721 COUPLED WEYL GRAVITATIONAL AND ZERO-REST-MASS SCALAR FIELDS. Gautreau, R. (Newark Coll. of Engineering, N. J.). Nuovo Cim., 62B: 360-70(Aug. 11, 1969).

The Einstein field equations are solved for the metric representing static coupled gravitational and zero-rest-mass scalar fields that depend on at most two variables. Several metrics are then analyzed to determine what changes occur in their singular structure when a zero-rest-mass scalar field is coupled to a vacuum gravitational field. In certain cases it is found that the addition of a zero-rest-mass scalar field can have the effect of changing some of the topological properties of the singularities of the corresponding vacuum field. (auth)

44722 PETROV CLASSIFICATION OF STATIONARY AXISYMMETRIC EMPTY SPACE-TIMES. Collinson, C. D.; Dodd, R. K. (Univ. of Hull, Eng.). Nuovo Cim., 62B: 229-34(Aug. 11, 1969).

The Petrov classification of stationary axisymmetric empty space-times is discussed. An error in the work of Lewis is corrected, thus revealing a family of stationary axisymmetric empty space-times not included in the usual canonical form for such space-times. (auth)

44723 HOW TO GET THE QUASI-UNIFORM GRAVITATIONAL FIELD FROM THE SCHWARZSCHILD METRIC. Karlov, L. (Univ. of Sydney). Amer. J. Phys., 37: 667-8(June 1969).

Some mathematical details involved in the derivation of the metric $ds^2 = (1 + 2gx/c^2)^{-1}dx^2 + dy^2 + dz^2 - (1 + 2gx/c^2)c^2dt^2$, representing flat space-time in a suitably accelerated reference frame, from the Schwarzschild metric $ds^2 = (1 - 2m/r)^{-1}dr^2 + r^2d\vartheta + r^2\sin^2\vartheta d\phi^2 - (1 - 2m/r)c^2dt^2$ are analyzed and clarified. (J.F.P.)

44724 QUADRATIC CORRECTIONS TO THE LAGRANGIAN GRAVITATIONAL FIELD DENSITY AND SINGULARITY. Ruzmaikina, T. V.; Ruzmaikin, A. A. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 57: 680-5(Aug. 1969). (In Russian).

The generalized lagrangian gravitational field density discussed by A. D. Sakharov is investigated in connection with the problem of nonsingular transition from constriction to expansion within the framework of the homogeneous and isotropic cosmological model. It is demonstrated that solutions which at later stages go over to the Friedman solution are singular at t = 0. (auth)

Scattering Theory

Refer also to abstracts 44574 and 44685.

44725 (AD-686370) AN INTEGRAL EQUATION FOR SCATTERING AMPLITUDES. Goldberger, Marvin L.; Chew, G. F.; Low, Francis E. (Princeton Univ., N. J. Palmer Physical Lab. California Univ., Berkeley. Lawrence Radiation Lab. Massachusetts Inst. of Tech., Cambridge. Dept. of Physics). Jan. 9, 1969. Contract AF49(638)-1545. 7p. (AFOSR-69-1011-TR). CFSTI.

A dynamical scheme is outlined for studying Regge behavior of scattering amplitudes. It is based on unitarity and the concept of short-range momentum-space correlations in high-energy processes. (auth)

44726 (CEA-R-3827) EXTENSION OF AXIOMATIC ANALYTICITY PROPERTIES FOR PARTICLES OF ARBITRARY SPIN, AND SUPERCONVERGENT RELATIONS. Mahoux, Gilbert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1969. 84p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, France.

It is shown that any regularized helicity amplitude, which is known from axiomatic local field theory to satisfy dispersion relations for $-t_M < t \leq 0$, is in fact analytic in the quasi-topological product $(|t| < R) \otimes (s \text{ in the cut plane})$. This is the extension to the scattering of spin particles, of a result obtained by Martin in the scalar case. As a first consequence, the Froissart limits are extended to all helicity amplitudes. Furthermore, it is shown that for $-t_M < t \leq 0$ and s going to infinity, the regularized helicity amplitudes in the t channel, with initial (respectively final) helicities λ_1 and λ_2 (respectively μ_1 and μ_2), are bounded by: $C_s^{1-\max}(|\lambda|,|\mu|)\log^2 s$ if $\lambda + \mu$ is even, $C_s^{1-\max}(|\lambda|,|\mu|)\log^3 s$ if $\lambda + \mu$ is odd where $\lambda = \lambda_1 - \lambda_2$ and $\mu = \mu_1 - \mu_2$. This gives superconvergent amplitudes as soon as one of the spins is larger than 1. The case of spin-0-spin-1 scattering is marginal, and in the absence of any detailed dynamical information, one cannot obtain a superconvergent amplitude in that case. (auth)

44727 UNITARITY STRUCTURE OF SCATTERING AMPLITUDES. Cronstroem, C. (Univ. of Helsinki). Acta Phys. Acad. Sci. Hung., 26: 101-5(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

As a first step towards constructing scattering amplitudes satisfying unitarity, analyticity and crossing symmetry, a linear non-

singular integral equation is derived for the total scattering amplitude which is equivalent to the unitarity condition. For this purpose the partial-wave N/D representation (with inelasticity) and the convolution theorem for Legendre transforms are used. A brief discussion is given of the choice of two functions N(s, cos Θ), C(s, cos Θ) which determine the unitary scattering amplitude through the integral equation. These functions may hopefully be chosen so that the analyticity and crossing symmetry requirements are satisfied. (auth)

44728 MULTIPERIPHERAL MODEL. Low, F. E. (Massachusetts Inst. of Tech., Cambridge). Acta Phys. Acad. Sci. Hung., 26: 65-9(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The multiperipheral Regge model attempts to substitute a more plausible model for the n-particle production amplitude which is significant in unitarity-type equations. (auth)

44729 THE VENEZIANO FORM. Goebel, C. (Univ. of Wisconsin, Madison). Acta Phys. Acad. Sci. Hung., 26: 71-6 (1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The Veneziano form is a model scattering amplitude which satisfies all finite energy sum rules. Its properties, some simple consequences, and the technique of constructing from it amplitudes with specified crossing symmetry are briefly described. Also the relation of the "Schmid circles" computed from it to its resonances is discussed. (auth)

44730 UNITARITY AND NON-REGGE SINGULARITIES. Bassetto, A.; Paccanoni, F. (Univ., Padua. Istituto Nazionale di Fisica, Padua). Acta Phys. Acad. Sci. Hung., 26: 77-9(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Continuing a relativistic amplitude into the complex angular momentum plane, new singularities are forced to appear from the crossed channel unitarity requirements. (auth)

44731 MULTI-REGGEON BEHAVIOUR OF PRODUCTION AMPLITUDES. Drummond, I. T. (Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.). Acta Phys. Acad. Sci. Hung., 26: 81-8(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Gribov has developed a calculus based on perturbation theory which permits a meaning to be attached to an arbitrary Reggeon diagram in two-body scattering. The rules that Gribov gives are for calculating the t-channel partial wave amplitude a(J,t). It is indicated how Gribov's discussion can be taken over to the case of production amplitude for the process A + B → 1 + 2 + 3. (auth)

44732 ANALYTICITY, FACTORIZATION, AND LORENTZ SYMMETRY. Di Vecchia, P. (California Inst. of Tech., Pasadena. CNEN, Rome); Drago, F. Acta Phys. Acad. Sci. Hung., 26: 35-46(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

The properties of the scattering amplitude near t = 0 were studied on the basis of analyticity, factorization and Lorentz symmetry. (auth)

44733 REGGE FAMILIES AND LORENTZ SYMMETRY. Tindle, G. L. (Univ. of California, Berkeley). Acta Phys. Acad. Sci. Hung., 26: 47-55(1969).

From Conference on Hadron Spectroscopy, Keszthely, Hungary. See CONF-680927.

Some of the fundamental ideas of the conspiracy problem are discussed in a simple way. It is shown why we are forced to consider families of Regge poles. A model in which Regge families are characterized by representations of the homogeneous Lorentz group is also examined. (auth)

44734 ANALYTIC CONTINUATION OF THREE-BODY OFF-THE-ENERGY-SHELL AMPLITUDES. Lancaster, K. G. (Univ. of Hull, Eng.). Nuovo Cim., 62B: 201-18(Aug. 11, 1969).

The analyticity of three-body partial-wave amplitudes is considered for an interaction in which the two-body amplitudes have a particular separable form. Unitarity and discontinuity are discussed, and the amplitudes are analytically continued into a limited region of meromorphy in the energy plane on the second sheet. (auth)

44735 RELATION BETWEEN THE ASYMPTOTIC VALUES OF PHASE AND MODULUS OF THE FORWARD ELASTIC SCATTERING AMPLITUDE. Vernov, Yu. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 10: 176-86(July 1969). (In Russian).

If the even amplitude of the forward elastic scattering, $f(E) = f_+(E)$, has not too strong oscillations, then $f(Ee^{i\varphi})/f(E)$ has lower and upper limits at $E \to \infty$. This fact enables one to express $|f(E)|$ through an integral of Im ln f(E). A number of asymptotic restrictions on $|f(E)|$ result, that depend on the ratio Imf(E)/Ref(E). The obtained relations are also valid for an infinite sequence of the energy values in case of arbitrary oscillations of $|f(E)|$. The quantity $|f(E)|$ is proved to have not too strong oscillations, if Im ln f(E) does not exist. The odd amplitude, $f_a(E) = f_+(E) - f_-(E)$, as well as the relation between $f_+(E)$, and $f_-(E)$, is also considered. (auth)

44736 A CROSSING-SYMMETRIC SOMMERFELD-WATSON TRANSFORMATION OF THE TWO-VARIABLE EXPANSION OF THE SCATTERING AMPLITUDE. White, A. R. (Univ. of Cambridge, Eng.). Nuovo Cim., 62A: 805-19(Aug. 21, 1969).

The scattering of two particles of equal mass is considered, and how a Sommerfeld–Watson transformation may be applied to the expansion of the amplitude given by Balachandran and Nuyts, if it is assumed that the amplitude is continuable in the complex plane of a crossing-symmetric angular-momentum variable is shown. It is shown that analyticity in this variable can be derived from the assumption of analyticity in the usual complex angular-momentum planes. (auth)

44737 AN INTRODUCTION INTO THE HIGHER SYMMETRIES OF REGGE-POLE. Sebestyen, A.; Szego, K.; Toth, K. (Central Research Inst. for Physics, Budapest). Fortschr. Phys., 17: 167-88(1969).

A review is given for the generalized partial wave analysis. The kinematics are summarized, Regge theory is reviewed, and the four-dimensional partial-wave analysis of the scattering amplitude for equal- and unequal-mass is given. The analytic properties of a Lorentz-pole contribution are examined in detail. The primary point of view is to become free of the unwanted s = 0 singularity. The particle spin is considered although the spin-type conspiracy is not investigated. (J.F.P.)

44738 HARMONIC-OSCILLATOR ANALOGY FOR THE VENEZIANO MODEL. Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev. Lett., 23: 545-7(Sept. 8, 1969).

A model for particle scattering amplitudes is based on the harmonic-oscillator Green's function. The model is Regge behaved, and in first approximation is a zero-width theory. The derived amplitudes are very similar to Veneziano n-point functions although they lack duality. (auth)

44739 CAN THE PHASE OF THE AMPLITUDE BE FOUND? Sakmar, I. A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim., Lett., 2: 256-62(Aug. 21, 1969).

The phase of the amplitude is found starting with the unitarity of the S-matrix. A condition is found which must be satisfied for determining the phase of the amplitude at any angle. This condition is satisfied for $\pi^+ + p$ scattering at 1236 MeV in the forward direction where the phase can be experimentally measured. The condition is violated at all other angles where it cannot be experimentally measured. (J.F.P.)

Particle Accelerators

Refer also to abstracts 43326, 43483, 43551, 43593, 43636, 44882, 44948.

44740 (AD-687392) NRL VAN DE GRAAFF OPERATION, JULY 1–DECEMBER 31, 1968. (Naval Research Lab., Washington, D. C.). Feb. 1969. 23p. (NRL-MR-1984). CFSTI.

A semiannual summary on the operation and use of the NRL 5-MV Van de Graaff accelerator and associated instruments is presented. Brief accounts of the research and development projects under way are included. (auth) (USGRDR)

44741 (ANL-7582) MIDWEST TANDEM CYCLOTRON: A PROPOSAL FOR A REGIONAL ACCELERATOR FACILITY. (Argonne National Lab., Ill.). June 1969. Contract W-31-109-eng-38. 410p. Dep. CFSTI.

The Midwest Tandem-Cyclotron is proposed as a regional facility to be built at Argonne National Laboratory for advanced research in nuclear chemistry and nuclear physics. The accelerator system would consist of a large 6-sector ring cyclotron whose injector is either a TU tandem Van de Graaff (for heavy ions) or a 4-sector cyclotron (for light ions). When not in use as an injector, the tandem would be used separately for research. The system would accelerate ions in all regions of the periodic table, providing continuously variable beam energies up to 350 MeV for protons and up to 8–10 MeV per nucleon for ions of the heaviest elements. After a brief general description of the proposed accelerator system and its use, the accelerators, the building, and the associated experimental facilities are described.

The relevant research capabilities currently existing at Argonne and in the universities of the Midwest are discussed. Finally, the character of the anticipated research on super-heavy elements, other experiments with heavy-ion beams, and research with light-ion beams are discussed. (auth)

44742 (BNL–13890) REMARKS ON FIELD EMISSION IN SUPERCONDUCTING RF CAVITIES. Halbritter, J. (Brookhaven National Lab., Upton, N. Y.). July 20, 1969. 11p. Dep. CFSTI.

An analysis of prebreakdown field-emitted electron currents in superconducting rf cavities is presented. It is shown that those currents are able to cause a frequency shift ($\Delta f \sim 1$ kHz at $f \simeq 3$ GHz) proportional to $E^{5} e^{-c/E}/f$. With these currents occurring, "processing" of TM modes in superconducting cavities possibly causes the burnt dark spots observed in niobium and lead cavities. (auth)

44743 (BNL–13942) SOME HIGH-CURRENT EFFECTS IN PARTICLE ACCELERATORS. Courant, E. D. (Brookhaven National Lab., Upton, N. Y.). [1969]. 6p. (CONF-690811–6). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

Instabilities and beam losses due to electromagnetic fields produced by high-current beams in accelerators are discussed. Space charge defocusing effects and negative mass instability are considered. Methods for compensation of longitudinal space-charge defocusing are discussed. (W.H.K.)

44744 (BNL–13943) PERFORMANCE OF THE SLOW EXTERNAL BEAM AT THE BROOKHAVEN AGS. Barton, M. Q. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-690811–5). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

A description of the AGS slow beam extraction system using a third integral nonlinear resonance is given. Over-all performance of the system is discussed. (W.H.K.)

44745 (BNL–13944) THREE TURN RESONANT FAST EXTRACTION. van Steenbergen, A.; Month, M. (Brookhaven National Lab., Upton, N. Y.). [1968]. 18p. (CONF-690811–7). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

As part of a study of the potential use of the AGS as a booster injector for a higher energy accelerator, the three turn resonant fast extraction technique is investigated. With this particular mode of extraction, three distinct stable domains are generated in the transverse phase space using a $\nu_x = 8/3$ nonlinear resonant excitation whereby the resonant growth is limited by means of the addition of octupole components in the azimuthal field distribution. Analytically, the stable fixed points and associated closed domains in the transverse phase space are calculated, specifically for the AGS, for certain ν value deviations from the resonant value. Using an AGS orbit program, particles are traced adiabatically through the resonance. It is found that particles can be made to migrate out of the central domain in x,x' phase space, surrounding the equilibrium orbit, into the three newly formed stable domains which are moving outward as the betatron frequency passes through its resonant value. Considerations related to the choice of sextupole and octupole strengths are presented. Starting from a Gaussian particle density distribution, the final distribution is obtained at a suitable extraction point in the AGS. The effect of ν value spread is also examined and approximate values for the effective phase space dilution are obtained. (auth)

44746 (BNL-tr–287) ACCELERATING STRUCTURE FOR A HIGH-ENERGY PROTON LINEAR ACCELERATOR. Andreev, V. G. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from a Russian report. 26p. Dep. CFSTI.

The small RF losses, the strong coupling between adjacent cells at comparatively low voltages on the coupling elements, the azimuthal symmetry of the accelerating field, and the simplicity in construction and technical preparation of a resonant cavity loaded with discs and excited in the $TM_{02\pi}$ mode are studied for a high-energy proton linear accelerator. (auth)

44747 (BNL-tr–290) MODERN RF ACCELERATING STRUCTURES FOR PROTON LINEAR ACCELERATORS. Andreev, V. G. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from a Russian report. 11p. Dep. CFSTI.

A brief review of the development of radiofrequency accelerating structures for proton linear accelerators is presented. (W.H.K.)

44748 (CERN-Trans–68-22) POSSIBILITIES OF RAPID EJECTION OF 85-GeV PROTONS FROM THE IFVE ACCELERATOR. Myznikov, K. P.; Tatarenko, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report IFVE-SKU–67-10. 22p. Dep.

A scheme for a somewhat modified fast ejection system is proposed. This system assures the extraction of 85-GeV protons in channels with considerably reduced field values for the kicker magnets, while eliminating completely the necessity of local deformations of the orbits. The extraction scheme is shown and described. (J.F.P.)

44749 (CERN-Trans–69-11) CALCULATION OF PARTICLE DYNAMICS AT THE TIME OF IMPINGING A BEAM OF PROTONS ON INTERNAL TARGETS OF THE SERPUKHOV ACCELERATOR. Gridasov, V. I.; Myznikov, K. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report IFVE-SKU–68-60. 31p. Dep.

The peculiarities of the dynamics for various methods of targeting in the real conditions of the IHEP accelerator are examined. The magnetic field characteristics used in the calculations are taken from the results of measurements in the ring magnet. (J.F.P.)

44750 (IFVE-INZH–68-63) PARAMETERS OF THE LINEAR ACCELERATOR I-100, DURING ACCELERATION OF BEAMS OF HIGH INTENSITY. Il'evskii, S. A.; Kapchinskii, I. M.; Polyakov, B. I.; Popinenkova, L. M.; Teplyakov, V. A.; Tishin, V. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 29p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The results of measuring the I-100 linac parameters, when a 100 mA current of protons was obtained, are presented. It is shown that in spite of large beam loading the width of the integral spectrum of the accelerated particles is not larger than the designed one. If the cavities are tuned more carefully it is possible to make the integral spectrum equal the momentary one. The momentary spectrum is close to the one, that was predicted theoretically for the ideal accelerating system. (auth)

44751 (IFVE-SKU–68-57) GENERAL SYSTEM OF THE PROTON BEAM REJECTION FROM THE ACCELERATOR OF THE INSTITUTE FOR HIGH ENERGY PHYSICS. Myznikov, K. P.; Sapunov, Yu. M.; Tatarenko, V. M.; Fedotov, Yu. S.; Frolov, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Basic principles of the rejection system for the proton beam in the experimental hall of the accelerator are described. There are three fast-rejection and two slow-rejection chambers for the protons, thus the experimental possibilities increase. Besides the possibilities of using the proton beam and the work of the channel many times per accelerating cycle are discussed. (auth)

44752 (IFVE-SKU–68-60) CALCULATION OF PARTICLE DYNAMICS DURING TRANSPORT OF ACCELERATED PROTON BEAM TO INTERNAL TARGETS OF THE IFVE ACCELERATOR. Gridasov, V. I.; Myznikov, K. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukov. Institut Fiziki Vysokikh Energii). 1968. 29p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The dynamics of accelerated protons when different methods of transporting the beam to internal targets are being applied is investigated. Taking into account the effective characteristics of the magnetic field measured at 4000 Oe and 12000 Oe, the main parameters (the shape of the closed orbit, the frequencies of the betatron oscillations) are calculated. (auth)

44753 (LNF–69/8) THE TRANSPORT CANAL OF THE EXTERNAL BEAM OF THE FRASCATI ELECTRON SYNCHROTRON. Note No. 431. Bizzarri, U.; Letardi, T. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). June 28, 1969. 22p. (In Italian). Dep.

The extraction method for the Frascati electron synchrotron is described. The characteristics of the extracted beam with respect to the duration of the spill out, energy dispersion, and beam emittance, and apparent position of the source are reported. The design of the three transport channels is given. The results of the measurements of the characteristics of the optical elements are reported. The mechanical development and beam profile are also discussed. (J.S.R.)

44754 (RHEL/R–171) FURTHER DEVELOPMENT OF THE MAGNETOSTATIC COMPUTER PROGRAMME TRIM AT THE RUTHERFORD LABORATORY. Diserens, N. J. (Ruther-

ford High Energy Lab., Chilton (England)). Jan. 1969. 21p. Dep. UK 7s. 0d.

TRIM is a computer programme, developed at L.R.L., Berkeley, California, for the solution of two-dimensional magnetic problems in systems of coils with iron. Further work on this programme at the Rutherford Laboratory, with particular reference to cylindrical geometry, is described. A series of simple analytic tests was used to pinpoint sources of error in the programme and to check the improved version. Tests against actual magnets showed that rotationally symmetric problems can now be handled with the same confidence as those of plane geometry. Among additional facilities incorporated in the programme is that of being able to specify a steady field external to a model; this makes possible the investigation of problems of screening equipment from external fields. Alternatively, by regarding a magnetic system as a dipole, and setting the boundary potentials accordingly, it is possible to determine the stray field external to a yoke or screen. (auth) (UK)

44755 (UCRL-18837) ACCELERATOR COOLING SYSTEMS. Eno, Eugene (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 4, 1969. Contract W-7405-eng-48. 89p. Dep. CFSTI.

The behaviour of accelerator cooling systems is discussed, and an attempt is made to explain the wide variation in the reported costs of cooling systems at various accelerator laboratories. First, alternate methods of cooling are analyzed as to concept, relative functional suitability, and relative cost. Second, a brief explanation is given of the theory of cooling towers. This explanation includes illustrations of the effects of atmospheric and operating conditions on the efficiency and, hence, the cost of cooling. Third, the economic and functional effects of cooling on other accelerator components are analyzed. Fourth, equipment associated with accelerator cooling systems is briefly discussed and evaluated. This equipment includes such things as heat exchangers, piping materials, and ion-exchange systems. Fifth, tables and charts are included which list the costs of cooling-system components. These prices are intended chiefly to illustrate the relative economic significance of the components and should be used for rough estimating only. Sixth, the cooling systems at existing accelerator laboratories are compared. The ultimate criterion for evaluation of cooling systems is their actual operating record. Records at LRL show that some of the accelerators have maintained an operating beam for more than 95% of the elapsed time, an enviable record. (auth)

44756 SHIELDING AGAINST NEUTRONS IN THE ENERGY RANGE 50 TO 400 MeV. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.); Mynatt, F. R.; Barish, J.; Engle, W. W. Jr. Nucl. Instrum. Methods, 72: 213-16(1969).

Neutron transport calculations have been carried out for monoenergetic neutrons normally incident on a semi-infinite slab shield of silicon dioxide with 5% water by weight. For incident neutron energies of 50, 100, 200, 300, and 400 MeV, results are given for the neutron flux per unit energy as a function of depth and energy and for the dose equivalent from neutrons and photons as a function of depth. (auth)

44757 AN AUTOMATIC BEAM POSITIONING SYSTEM FOR LOW ENERGY ION BEAMS. Brown, R. B.; Bourland, P. D.; Powers, D. (Baylor Univ., Waco, Tex.). Nucl. Instrum. Methods, 72: 217-19(1969).

A system is described for automatically translating and deflecting ion beams by feedback-controlled electrostatic deflectors to fix the beam position independent of accelerator and quadrupole focusing conditions. (auth)

44758 ROTATING TARGET FOR CONVERSION ELECTRON MEASUREMENT. Osterman, P.; Waldschmidt, M.; Rauch, F. (Univ., Frankfurt am Main). Nucl. Instrum. Methods, 72: 226-9(1969). (In German).

With a rotating target assembly for the measurement of conversion electrons the excitation functions of ^{79m}Kr and ^{81m}Kr, formed in (p,n)-reactions, have been obtained. (auth)

44759 COLD TARGET TECHNIQUES. Fulbright, H. W. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods, 72: 229-30(1969).

A device is described which makes possible the preparation and use of targets frozen from the vapor phase onto a thin, liquid nitrogen cooled substrate. The device can also be used as a cold shroud to protect ordinary targets held at room temperature. (auth)

44760 AN IMPROVED METHOD FOR PRODUCING LITHIUM METAL TARGETS. Nobes, M. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 72: 231-2(1969).

A technique is described for transferring lithium metal targets from an evaporator to a target can without contamination, use being made of liquid nitrogen as the storage and transfer medium. (auth)

44761 A BEAM CHOPPER FOR USE WITH A 60" FIXED FREQUENCY CYCLOTRON. Fauska, H.; Karns, R. E.; Drake, D. M. (Univ. of Washington, Seattle). Nucl. Instrum. Methods, 72: 233-4(1969).

An easily removable deflecting system for the elimination of two out of every three rf beam bursts from a 60" cyclotron is described. The system uses deflection plates which are part of a rf tank circuit. They are located where the beam emerges from the cyclotron and are driven at voltages exceeding 40 kV at a frequency one third that of the cyclotron. (auth)

44762 COOLED GAS TARGET SYSTEM FOR ELECTRON SCATTERING. Singhal, R. P.; Purdie, H.; Cave, A.; Pearce, E.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon Can.). Nucl. Instrum. Methods, 73: 237-9(1969).

A high pressure (~15 atm) cooled gas target system suitable for high resolution electron scattering measurements on rare isotopes at about 100 MeV incident electron energy is described. (auth)

44763 AN ION SOURCE USING LITHIUM VAPOR EXCHANGE AND GIVING SEVERAL MICROAMPERES OF $^4He^-$ OR $^3He^-$. Chapman, K. R. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods, 73: 255-9(1969).

An optical bench type ion source has been developed which uses lithium vapor exchange. The lithium reservoir holds a charge sufficient for over 350 h of operation and can be changed rapidly without disturbing the electrode alignment. The source has interchangeable exchange canals for operating with either lithium or hydrogen exchange. A coupling has been developed which enables the cooling lines to be coupled easily and without leakage problems. The use of freon as a coolant avoids previous problems with spillage of high vapor pressure coolant oil inside the vacuum system. (auth)

44764 VERTICAL TYPE CRYOSTAT FOR A POLARIZED PROTON TARGET. Hasegawa, T. (Kyoto Univ.); Horikawa, N.; Nishimura, K.; Nakanishi, T.; Saito, M.; Saito, T.; Takasaki, E.; Sugimoto, S.; Ueno, H.; Yamaki, T. Nucl. Instrum. Methods, 73: 349-50(1969).

A vertical type cryostat for the polarized proton target is described. This is used for the p-p scattering experiment at 50 MeV. The temperature reached is about 1.0°K with no microwave power. (auth)

44765 THE TRANSPORT OF NEUTRONS PRODUCED BY 3-GeV PROTON-LEAD NUCLEUS COLLISIONS THROUGH A LABYRINTH AND COMPARISON WITH EXPERIMENT. Alsmiller, R. G. Jr.; Solomito, E. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 73: 280-4(1969).

Calculated values of the thermal-neutron flux and the neutron flux above the cadmium cutoff as a function of position in a labyrinth of rectangular concrete ducts are compared with experimental values. In the calculations the approximation of neglecting all incident neutrons with energy greater than 10 MeV and all incident charged particles was made. The results do not give an unambiguous answer concerning the validity of this approximation because the calculated and experimental values are in good agreement in only one of the three cases considered. (auth)

44766 DEPOLARIZATION AND EMITTANCE DEGRADATION EFFECTS ASSOCIATED WITH CHARGE TRANSFER IN A MAGNETIC FIELD. Ohlsen, G. G.; McKibben, J. L.; Stevens, R. R. Jr.; Lawrence, G. P. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods, 73: 45-52(1969).

The effects on beam emittance and polarization which result from charge-transfer collisions within a magnetic field region are quantitatively discussed. The minimum magnetic field strength required to prevent depolarization under various circumstances is given. It is concluded that the Lamb-shift type of polarized-ion source has significant advantages over conventional polarized-ion sources if negative ions are required. (auth)

44767 THE SLAC MONOCHROMATIC PHOTON BEAM. Ballam, J. (Stanford Univ., Calif.); Chadwick, G. B.; Guiragossian, Z. G. T.; Kilert, A.; Larsen, R. R.; Leith, D. W. G. S.; Williams, S. H. Nucl. Instrum. Methods, 73: 53-60(1969).

A multi-GeV monochromatic photon beam is operational at SLAC. The energy spectrum consists of a monochromatic part, derived from the in-flight annihilation of positrons, superimposed on the usual thin target bremsstrahlung. The beam has been successfully utilized in the study of photoproduction processes by both bubble chamber and spark chamber techniques. (auth)

44768 ENERGY ABSORBER FOR EXTERNAL BEAMS OF KARLSRUHE IOCHRONOUS CYCLOTRON. Muenzel, H.; Busch-

mann, J.; Christaller, G.; Hartmann, D.; Hartwig, D.; Michel, F.; Schneider, R.; Schwarzbach, E. Kernforschungszentrum Karlsruhe, Ger.). Nucl. Instrum. Methods, 73: 103-8(1969). (In German).

An energy absorber was constructed to reduce the energy of the external deuteron or alpha beam of the Karlsruhe isochronous cyclotron. Thin plates of beryllium stepped by 1.0 and 0.1 mm, respectively, are mounted at the top of two closely arranged rods. Two other rods support a ZnS-screen, a beam centering device, a beam measuring foil as well as a beam mask. The following tests are described: measurement of energy, energy straggling and angular distribution of the attenuated particles; transmission measurements of the refocusing lens system; indirect beam current measurements via secondary electrons. (auth)

44769 A FACILITY FOR MEASURING CROSS SECTIONS OF (n,xγ) REACTIONS USING AN ELECTRON LINAC. Orphan, V. J.; Hoot, C. G.; Carlson, A. D.; John, Joseph; Beystler, J. R. (Gulf General Atomic Inc., San Diego, Calif.). Nucl. Instrum. Methods, 73: 1-12(1969).

A facility for the study of gamma rays resulting from non-elastic neutron interactions for energies from the keV region up to about 16 MeV is described. An electron linac is used to produce a beam of pulsed neutrons. The gamma-ray energies and intensities are measured using a Ge(Li) detector and the corresponding neutron energy is determined by the time-of-flight technique. A computerized data acquisition system for processing the two-parameter data is described. The principal features and operating characteristics of the facility are discussed and gamma-ray spectra resulting from the neutron bombardment of nitrogen and oxygen are shown. (auth)

44770 SACLAY'S LINEAR ACCELERATOR (A.L.S.). Bull. Inform. A.T.EN. (Ass. Tech. Energ. Nucl.), No. 75, 44-8(Jan.-Feb. 1969). (In French).

The characteristics and performance of the Saclay 600-MeV linear accelerator for electrons and positrons are given. Graphs showing the energy as a function of the beam current, the displacement of the energy point during a 24-hr period, and the energy spectrum of the electron beam are presented. (J.S.R.)

44771 STUDY FOR A RADIAL SECTOR-TYPE FFAG ELECTRON SYNCHROTRON. (ENERGIES TO 150 MeV). IX. THE MOTION OF CHARGED PARTICLES IN TIME CONSTANT ELECTRIC AND MAGNETIC FIELDS CONSIDERING SPACE-CHARGE EFFECTS. Hoffmann, G. (Freie Univ., Berlin). Nucl. Instrum. Methods, 73: 132-40(1969). (In German).

The equations of motion of charged particles in electric and magnetic fields, constant in time, are derived from a Hamiltonian taking account of space charge and self-magnetic field of the electron beam. It is assumed that the charge distribution is constant across the beam diameter and that the transverse components of beam current are negligible. The equations of motion are specialized to FFAG-accelerators and are integrated numerically. From the equation of motion one can derive a formula useful to estimate the lowering of betatron frequencies. An accurate calculation is done with the theory of Hill's differential equations. The variations of betatron frequencies are not proportional to the circulating current if the maximum amplitudes of the betatron oscillations are kept constant. Within 2% the curves can be approximated by straight lines up to a current of I = 5 A. Hereby the radius of the electron beam does not change, but the magnitude of the acceptance area is lowered with increasing space charge density, so that the emittance of the injector also must be reduced. The effect of space charge on the motion in the vertical plane is larger than that in the horizontal plane. (auth)

44772 STUDY FOR A RADIAL SECTOR-TYPE FFAG ELECTRON SYNCHROTRON. (ENERGIES TO 150 MeV). X. THE CONSTRUCTION OF THE INJECTION SYSTEM CONSIDERING SPACE CHARGE EFFECTS. Hoffmann, G. (Freie Univ., Berlin). Nucl. Instrum. Methods, 73: 141-7(1969). (In German).

The equations of motion which are derived in a previous paper are specialized to the magnetic and electrostatic inflector. The transformations of acceptance ellipses by the inflectors are calculated. The equations are applied to the motion of charged particles in bending magnets, quadrupoles and field-free spaces. Penner's known matrix formalism is derived from these equations in the case of negligible space charge. It is used in dimensioning a 90°-bending magnet. By means of an electron gun the transformation of the emittance area by this magnet is studied experimentally and compared with numerical calculations. The beam diameter is still calculated too small. Nevertheless the consistency is much better than without taking into account the space charge. The existing difference is cleared up. The construction of injection system is carried out by means of the derived equations of motion considering symmetry properties of beam handling systems. (auth)

44773 THERMIC JOINT. Ambard, G. (CEN, Saclay, France). Nucl. Instrum. Methods, 73: 223-4(1969). (In French).

A target of polarized protons is glued on a plate of crystallized quartz which is soldered to a copper cryostat full of liquid helium. The soldering process is described. (auth)

44774 A METHOD TO ENSURE ELECTRODE ALIGNMENT IN AN ION SOURCE WITHOUT ACCELERATOR DOWN TIME. Chapman, K. R. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods, 73: 234-6(1969).

A method has been developed which allows an electrode to be adjusted with respect to its mounting base. This enables accurate alignment to be obtained without close machining tolerances and maintained in spite of aperture erosion. The use of an off-line alignment apparatus allows an electrode to be accurately set without the need to interrupt the accelerator operating schedule. Thus any electrode may be serviced and new or experimental electrodes completed and they will be accurately aligned when mounted into the source. (auth)

44775 CYCLOTRONS FOR THE ACCELERATION OF HEAVY IONS. Boettger, O. (Allgemeine Elektricitaets Gesellschaft, Frankfurt am Main). Nucl. Instrum. Methods, 73: 200-4(1969).

Two cyclotrons are discussed, one for accelerating nuclei up to an atomic weight of about 20, built to some 1.25 m machine-radius, another for nuclei weighing about 40 and having approximately 1.75 m machine-radius. Proposals are further made aiming at an acceleration to some 7 MeV/nucleon of nuclei up to 238 atomic weight by the use of two series-connected machines. The possible series connection of a tandem accelerator and a cyclotron is also briefly discussed. (auth)

44776 DYNAMIC PROTON POLARIZATION IN BUTANOL WATER BELOW 1 K. Hill, D. A. (Argonne National Lab., Ill.); Ketterson, J. B.; Miller, R. C.; Moretti, A.; Niemann, R. C.; Windmiller, L. R.; Yokosawa, A.; Hwang, C. F. Phys. Rev. Lett., 23: 460-2(Sept. 1, 1969).

The temperature dependence of the dynamic proton polarization in a 0.2-g sample of 95% 1-butanol and 5% water, containing 0.75% of the free radical porphyrexide was measured between 1.4 and 0.5 K. The largest polarization attained was 67% at 0.5 K. The feasibility of achieving comparable polarization in larger samples and the question of the origin of the observed temperature dependence are discussed. (auth)

44777 EVA, THE 85 MeV LINEAR ELECTRON ACCELERATOR (VERSNELLER) AT AMSTERDAM. Bruinsma, P. J. T.; Noomen, J. G.; De Vries, C. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods, 74: 1-4(1969).

The 85 MeV electron linac of the Institute for Nuclear Physics Research in Amsterdam (EVA) is now fully operational. At high energies and low currents, 80% of the current of the low-emittance beam falls within a 0.3% energy-band. Maximum peak currents of up to 150 mA within a 0.8% energy-band are obtainable regularly. This performance is attained using two SLAC sections (each 3 m long), and a Frascati-type injector. The inherent properties of both are matched by the performance of the peripheral equipment which includes two klystron modulators, the cooling system, the microwave driver and interface instrumentation. (auth)

44778 THE 100-MeV ELECTRON SCATTERING FACILITY AT AMSTERDAM. De Vries, C.; Bruinsma, P. J. T. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods, 74: 5-12(1969).

The facility for electron scattering experiments with the beam from the 85 MeV linear electron accelerator at Amsterdam (EVA) is described. The beam handling system allows research to be carried out with a purified beam of well defined energy and energy-spread. Up to 15 μA average current is achieved within an energy-band of 0.3%. The current at the target is monitored to an absolute accuracy of a few tenths of one percent. The magic-angle spectrometer (ρ_0 = 65 cm) allows measurements at high resolution (fwhm ≦0.2%) and yet with a relatively large solid angle (6 mster). The counting system consists of ten partially overlapping plastic scintillators, and detects scattered electrons simultaneously in 19 narrow channels. Experiments can be performed at scattering angles between 35° and 150°. In addition a special magnet arrangement permits scattering experiments at 180°. Experimental data to illustrate the overall performance are given in subsequent articles which describe the main components of the system in more detail. (auth)

44779 HIGH PRECISION ELECTRON CURRENT MONITORING SYSTEM. Jansen, J. A.; Veenhof, G. J.; De Vries, C. (Inst. for Nuclear Physics Research, Amsterdam). Nucl. Instrum. Methods, 74: 20-6(1969).

A high precision current monitoring system is installed for use with the electron scattering facility of the 85 MeV electron linac

at Amsterdam. It consists of a toroid current monitor upstream of the target in conjunction with a Faraday cup far beyond the target. Quadrupole magnets between the target and the cup limit the current loss due to the divergence of the beam emerging from the target. The losses are measured to high precision by feedback techniques. The overall accuracy in the determination of the primary beam current is in the order of a few tenths of a percent. (auth)

44780 SINGLE-PULSE TRIGGER GENERATOR FOR A 10 MeV ELECTRON LINEAR ACCELERATOR. Fenger, J. (Danish Atomic Energy Commission, Risoe). Nucl. Instrum. Methods, 74: 93-6(1969).

A new trigger generator has been designed in order to make the Varian V-7700 accelerator suited for pulsed radiolysis experiments. Provisions have been made to obtain single electron pulses with small variations in pulse dose. The obtained electron pulse width is continuously adjustable from 0.25–4 μsec, the pulse width jitter is max. 20 nsec. Variation in the average electron energy from pulse to pulse is reduced to 1%. For a 1 μsec electron pulse, the typical pulse width used for pulsed radiolysis, the dose variation from pulse to pulse will not excess more than 3%. (auth)

44781 FIRST ORDER PERTURBATION EFFECTS IN IRON-DOMINATED TWO-DIMENSIONAL SYMMETRICAL MULTIPOLES. Halbach, K. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 74: 147-64(1969).

The effects of several perturbations are investigated. They are: modification of the shape of a pole, error excitation, displacement, and rotation of a pole. The effects are described in terms of changes of multipole coefficients. General relationships between some of these coefficients are described, and formulae are derived that allow their calculation for a model 2N-pole magnet. Numerical values of these coefficients are given for a quadrupole, sextupole, and octupole. (auth)

44782 IMPROVEMENTS IN OR RELATING TO STATIC ATMOSPHERE ION BEAM ACCELERATORS. (to Dresser Industries, Inc.). British Patent 1,161,897. Aug. 20, 1969. Priority date Aug. 25, 1965, United States.

The design of an improved ion beam accelerator which has a single sealed atmosphere for use primarily in well logging systems is described. The tubular housing is designed to contain a target for production of neutrons or gamma radiation. (W.H.K.)

44783 DEUTERON ACCELERATION BY SATURNE. Chamouard, P.; Joubert, A.; Thevenet, B. (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 137, 19-22(May 1969). (In French).

Having outlined the advantages offered to high-energy physicists by the 2.3 GeV deuteron beam, the modifications by which deuteron acceleration in Saturne is possible, are described and the results obtained presented. (auth)

44784 CYCLOTRON SOURCE OF H_3^+ AND He_3^+ IONS. Taut, T. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Roum. Phys., 14: 381-5(1969). (In Russian).

Preparation of H_3^+ and He_3^+ ion sources and elementary processes resulting in their formation are analyzed. Descriptions are given of the special position of plasma in inhomogeneous magnetic field and of the construction of an axial, closed-type source with a direct incandescence designed for the cyclotron-C-200. (tr-auth)

44785 PERFECT ANGULAR FOCUSSING IN TRANSVERSE MAGNETIC FIELDS. Ioanoviciu, D. (Institut de Physique Atomique, Cluj). Rev. Roum. Phys., 14: 337-44(1969). (In French).

Conditions for perfect angular or linear focussing of ion beams in transverse magnetic fields are derived. The field boundary forms were established for the following fields: homogeneous function of the abscissa non-homogeneous axially-symmetric H_1r_1/r (equally for spiral trajectories). (auth)

44786 PERFORMANCES OF A POSITIVE ION SOURCE EXCITED BY A LOW R. F. POWER IN AN UNDULATORY CROSS MAGNETIC FIELD. Pascalau, M. (Institutul de Fizica Atomica, Cluj). Stud. Cercet. Fiz., 21: 481-8(1969). (In Rumanian).

An ion source excited by a low rf power source (15 W) to obtain an ion beam with narrow energy source is described. The choice of a convenient geometry of the extraction electrode, the use of an undulatory current of auxiliary magnetization, and electronic resonance, allowed the extraction from the source of an ion current above 1 mA. (auth)

44787 HIGH CURRENT RADIO FREQUENCY ION SOURCE WITH NON-MAGNETIC ANALYZER. Hanna, N. N.; Morsy, M. W. (Atomic Energy Establishment, Cairo). Atomkernenergie, 14: 329-32(1969).

A high current positive ion source employing a non-magnetic analyzer technique is described, with the eventual purpose to overcome the difficulties involved in extracting and containing ion beams under space charge effects. The refinements, which are rather scattered in the literature are included in the design of a new R. F. ion source. In addition, the quadrupole mass filter is utilized in analyzing the extracted ion beam. Some of the limitations of the proposed ion source are discussed. (auth)

44788 A SPECIAL SAMPLING ATTACHMENT FOR MEASURING THE DISTRIBUTION OF CHARGE OF ACCELERATED ION BULKS IN THE ROSSENDORF CYCLOTRON. Kerber, G.; Odrich, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 12: 166-70(May 1969). (In German).

A sampling attachment has been developed for measuring the charge distribution in the ion beam of the Rossendorf cyclotron. Its upper limit of frequency is 140 MHz. Input impedance is 100 kΩ and 5 pF. Maximum sensitivity including reading oscillograph was 15 mV/cm. 1 ns of the signal pulse is represented by max. 2 points on the reading oscillograph. The external triggering is within the range of 10 to 200 kHz. (auth)

44789 EXPERIMENTAL STUDY OF ACCUMULATION OF PROTONS IN STORAGE RING (BETATRON REGIME). Dimov, G. I.; Dudnikov, V. G.; Sokolov, A. A.; Shamovskii, V. G. At. Energ. (USSR), 27: 130-3(Aug. 1969). (In Russian).

Accumulation of protons in the weak-focusing ring (r = 42 cm) with use of the charge-exchange method was carried out. The energy of injection was 1 MeV. The longitudinal instability and the effects limiting the intensity of the rotating beam were investigated. (auth)

44790 CANCELLATION OF EXTERNAL MAGNETIC FIELDS BY INNER AND OUTER CYLINDRICAL CURRENT SHEETS. Beth, R. A. (to United States Atomic Energy Commission). U. S. Patent 3,466,499. Sept. 9, 1969.

A shielding apparatus for providing a zero external magnetic field around a magnet is described. In one embodiment for focusing a beam of charged particles, a first 2n pole magnet forms a first cylindrical current sheet for producing a constant gradient magnetic field for focusing the charged particle beam along the axis of the first magnet, and a second 2n pole magnet forms an oppositely energized, concentric, outer, corresponding, second current sheet for effecting the distribution of the magnetic lines of force between the first and second current sheets to produce a zero field external to the second current sheet in accordance with the constant gradient magnetic field inside the first magnet. (AEC)

44791 ACCELERATOR APPARATUS AND METHOD OF SHAPING CAVITY FIELDS. Giordano, S. T. (to United States Atomic Energy Commission). U. S. Patent 3,466,554. Sept. 9, 1969.

Transverse stem resonance means for decreasing beam loading and tank detuning effects and for providing high shunt impedance for the production of high energy, high density, charged particle beams in a linear accelerator are described. (AEC)

44792 MECHANICAL SYSTEM DESIGN FOR TEXAS A AND M CYCLOTRON. Williamson, J. C. (Lockwood, Andrews, and Newman, Inc., Houston, Tex.). Heat., Piping Air Cond., 40: No. 11, 95-9Nov. 1968).

Design problems in the construction of the building and support systems for the Texas A and M variable energy cyclotron are discussed including high ventilation rates in vault, pit, and caves; maintaining pressure balance with varying laboratory fume hood exhaust; and providing high purity cooling water. (W.H.K.)

44793 ON THE POSSIBILITY OF H_3^+ ION ACCELERATION IN ISOCHRONOUS CYCLOTRON. Taut, T. (Joint Inst. for Nuclear Research, Dubna, USSR). Rev. Roum. Phys., 14: 261-70(1969). (In Russian).

The production and acceleration of H_3^+ ions in isochronous cyclotrons are studied and the conditions conducive to their disintegration during the process of acceleration are analyzed. Quantitative data obtained for the magnitude of certain machine parameters (compression, energy augmentation by rotation, rays of the final orbit, etc.) determine features which contribute to the H_3^+ ion acceleration. Calculations were made for the values of the cyclotron C-200. (tr-auth)

44794 MINIMUM APERTURE ABERRATIONS OF QUADRUPOLE LENS SYSTEMS. Moses, Ronald Wilson Jr. Madison, Wis., Univ. of Wisconsin, 1968. 335p.

Thesis.

A focusing system for monochromatic beams of charged particles, with magnetic quadrupole fields having common planes of optical symmetry is treated theoretically. In a doubly focusing system that has a real object and a real image, all aperture aberration coefficients are positive definite. After specifying certain

linear focusing properties for such systems, the calculus of variations is applied to obtain systems with minimum aperture aberrations. First order variational theory is applied to obtain the Euler equations that define extremal systems. This derivation gives four second order, coupled, ordinary differential equations. An iterative technique is presented for solving these Euler equations. Second order variational theory is employed to prove that the extreme of the aperture aberrations are local minima with respect to other systems having the same specified linear focusing properties. A digital computer was used to calculate a variety of systems with minimum aperture aberrations. Sample calculations are given for systems with magnifications of -1, -2, -5, and -10. General studies are presented for high magnification systems where the lenses are either confined to a region near the object or allowed to cover the entire system. In the former case the best orthomorphic systems have four lenses while the best anamorphotic systems have three. In the latter, the best orthomorphic systems have six lenses. Several methods for regulating the quadrupole gradient strength are studied. It is found that optimum systems have aberration coefficients about an order of magnitude smaller than the best systems previously studied. It appears that quadrupoles alone are not as good as round lenses, but combinations of quadrupoles and octupoles with realistic fields could be better. (Disser. Abstr.)

44795 NOTE ON RELATIVISTIC ELECTRON ORBITS IN CROSSED FIELDS. Miyajima, Shigeki (Nagoya Univ., Japan). Electron. Commun. Jap. (Engl. Transl.), 51: 100-1(May 1, 1968).

Controlling the orbit of an electron may be achieved by adjusting the magnitudes of B^2 and E^2/c^2 suitably and taking advantage of the inequality between them. A general method based on the special relativity theory was presented earlier for the calculation of the orbit of a charged particle in the presence of electric and magnetic fields crossed at an arbitrary angle. The orbit for fields crossed perpendicularly can be classified into 3 types depending on whether $B^2 >$, $=$, or $< E^2/c^2$. Orbits of these 3 types are shown. When $B^2 > E^2/c^2$, the orbit of a charged particle is the resultant of an elliptical motion and a linear motion which is perpendicular to both E and B. When $B^2 = E^2/c^2$, motion can be expressed by means of an algebraic equation of the second and third degrees with respect to the characteristic time. When $B^2 < E^2/c^2$, the solution involves hyperbolic functions. Typical orbits of an electron are shown for each case. (BBB)

44796 THE EMPEROR TANDEM AT YALE. Bromley, D. A. (Yale Univ., New Haven). J. Phys. (Paris), 30: Colloq. C2, 44-6(May-June 1969).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The first MP tandem Van de Graaff accelerator was installed in the Wright Laboratory late in 1966. Since that date it has been employed in an extensive research program utilizing both light and heavy projectiles on targets throughout the periodic table. Operating characteristics of the accelerator are presented and an illustration is made on their utilization with reference to current research in the laboratory including isobaric analog studies of nuclear structure and reactions in the lead region, nuclear spectroscopic studies in light nuclei, and Coulomb excitation of transition nuclei and heavy ion interaction mechanisms. Some characteristics of the associated research instrumentation will also be discussed. (auth)

44797 INJECTION OF HEAVY IONS INTO THE VARIABLE ENERGY CYCLOTRON AT ORSAY. Cabrespine, A. (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 30: Colloq. C2, 38-43(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

Heavy ions, preaccelerated at 1 MeV/amu, pass through a thin foil in the central region of the cyclotron. At this stage, they are accelerated with a much higher electronic charge than the charge produced by a multicharged ion source. The new capabilities, the efficiency, and the ability of varying the energy of the machine were analyzed. (auth)

44798 GRENOBLE CYCLOTRON. Depommier, P. (Institut des Sciences Nucleaires, Grenoble, France). J. Phys. (Paris), 30: Colloq. C2, 34-7(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The present state of the Grenoble variable-energy cyclotron (maximum energy for protons : 50 MeV) is discussed. After a short description of the machine and beam transport system, a brief account of the planned experimental program is given. (auth)

44799 POLARIZED SOURCES AND TARGETS. Beurtey, R.; Borghini, M. (CEN, Saclay, France. CERN, Geneva). J. Phys. (Paris), 30: Colloq. C2, 56-63(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The present state of proton and deuteron polarized sources and targets is examined, together with the future possibility of increasing the number of particles and the polarization with a view to their utilization in high energy physics. Some methods are suggested for polarizing other types of particles and materials. (auth)

44800 PROTON SYNCHROTRON PROJECT OF 23/45 GeV. Neyret, G. (CEN, Saclay, France). J. Phys. (Paris), 30: Colloq. C2, 27-33(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The main features of the 45 GeV proton synchrotron project are discussed and the new version is described. The advantages of building this machine in two stages with a location at St.-Aubin are developed. (auth)

44801 SACLAY ELECTRON LINEAR ACCELERATOR. Leboutet, H. (CSF, Corbeville, France); Azam, G.; Netter, F. J. Phys. (Paris), 30: Colloq. C2, 13-26(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

The accelerator is designed to operate at high duty cycle (2% maximum), high intensity (up to 60 mA peak current) and maximum energy of around 600 MeV at zero current. Results are given of the various tests performed, with emphasis on the main factors contributing to the narrow energy spectrum (< 1%) and to the high stability of the characteristics of the powerful beam (about 100 kW mean power). (auth)

44802 ELECTRON-POSITRON COLLISION RING AT ORSAY. Marin, P. (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 30: Colloq. C2, 7-12(May-June 1969). (In French).

From Conference on Experimental Methods in Nuclear and Particle Physics, Strasbourg, France. See CONF-681208.

After a brief description of the ring, a short survey is given of the new phenomena found in the behavior of the beams. The performance achieved is then presented: luminosity, lifetime of the beams, background, etc. A short account of the high energy physics experiments, which have been made in the past two years with ACO, is then given, as well as future scope for various improvements of the ring performance and new experiments in preparation. Some considerations on a bigger electron-positron colliding-beams project, using the 2.3 GeV Orsay linac as injector, are briefly outlined. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 44756, 44769, 44782, and 44848.

44803 (GA-9201) GAMTRI: A PROGRAM FOR THE SOLUTION OF THE MULTIGROUP NEUTRON-DIFFUSION EQUATIONS IN TRIANGULAR GEOMETRY WITH ARBITRARY GROUP SCATTERING, FOR THE UNIVAC-1108 COMPUTER. Dorsey, J. P.; Froehlich, R. (Gulf General Atomic, Inc., San Diego, Calif.). May 12, 1969. Contract AT(04-3)-167. 114p. Dep. CFSTI.

The numerical methods used in the program are described. The operating instructions for the program are given and a sample problem is presented. (J.W.R.)

44804 (JPRS-48421) NEUTRON SOURCES. Bak, M. A.; Shimanskaya, N. S. Translation of Neitronnye Istochniki, Moscow, Atomizdat Publishing House, 1969. 142p. CFSTI.

Chapters on fundamental properties of neutron sources, isotope neutron sources, accelerator-type sources, fission sources, reactor sources, metrology of sources, and dosimetry and radiation protection are included. (J.W.R.)

44805 (TID-25165) CINDA 69: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). May 1969. 1156p. (EANDC-80-U; CCDN-CI-24). DTIE Free.

A bibliography is presented for literature on cross section information and other microscopic data for neutron-induced reactions. The print-out type format includes the isotopes studied, the quantity measured, the neutron energy, the reference, the date and laboratory, and other comments. (J.W.R.)

44806 (WANL-TME-1933) TESTS OF THE GGC-3, GGC-4 NEUTRON SLOWING DOWN CODES AND COMPARISONS WITH THE CODES GAMBIT AND TRANSFER. Gibson, Gordon; Moran, L. L. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). May 1969. Subcontract SNP-1. 38p. Dep. CFSTI.

The GGC-3 and GGC-4 programs for multigroup cross sections are compared with the GAMBIT and TRANSFER programs. Some calculations done by the GGC-3 and GGC-4 codes on the CDC-6600 are presented and compared with similar calculations done by the GAMBIT and TRANSFER codes. (J.W.R.)

44807 THE INFLUENCE OF SOURCE DIMENSIONS OF THE FLUX DISTRIBUTION AROUND THE NEUTRON SOURCE OF A T(d,n) TYPE NEUTRON GENERATOR. Op de Beeck, J. P. (Ghent Univ.). Radiochem. Radioanal. Lett., 1: 281-7(Aug. 13, 1969).

Replacing a tritium target in a T(d,n) type neutron generator by one with greater diameter does not give all the improvements expected from an activation analyst's point of view. An exact calculation of the neutron flux points to poor neutron economy and the possibility of increasing flux gradients. (auth)

44808 EFFECT OF BROADENING OF INCIDENT NEUTRON ENERGY IN MEASURING SCATTERING LAW. Ayao, Shinji; Iizumi, M. (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 410-13(July 1969).

It is shown that the effect of incident neutron energy broadening should not be neglected in measuring the scattering law when the energy resolution exceeds 10%. (J.W.R.)

44809 A REPORT ON THE DETERMINATION OF THE FAST FISSION FACTOR OF BERYLLIUM OXIDE. Kirch, N.; Hecker, R. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 12: 175-82(May 1969). (In German).

In different experiments independent of one another the fast fission factor ϵ_{BeO} of BeO was measured for finite samples. ^{252}Cf (spontaneously fissioning) and a ^{235}U converter excited by thermal neutrons served as the fission neutron source. The neutrons were detected by the manganese sulfate bath technique and by a cadmium-loaded scintillation tank. All experiments led to a value for ϵ_{BeO} of 1.047 ± 0.004. In this final result is included a correction of 9% for the limited diameter of the BeO sample. With the method used for this correction ϵ_{BeO} was determined analytically to be 1.049, from the existing data for the effective cross section. (tr-auth)

44810 SOLUTIONS OF BOLTZMANN EQUATION IN HYDROGENOUS CHAIN REACTING SYSTEM. Yamagishi, Tomejiro; Sekiya, Tamotsu (Osaka Univ.). Technol. Rep. Osaka Univ., 19: Nos. 853-75, 29-37(Mar. 1969).

Solutions of space-time-energy-dependent neutron slowing down Boltzmann equation are investigated in the hydrogenous chain reacting system with modulated source by the method of Fourier-Laplace transformation. For anisotropy of scattering, the Selengut-Goertzel approximation is used. The double transformed solution in the chain reacting system is represented by a transformed Green's function in the nonmultiplying medium. A remarkable difference is observed between them for space-dependence: the latter has not any neutron wave propagation mode, while the former may have the property of wave propagation. The critical condition of the system is derived from the existence of the stationary solution. (auth)

44811 DETERMINATION OF HETEROGENEOUS PARAMETERS BY THE NEUTRON WAVE TECHNIQUE. Bernard, Emile Anthony. Gainsville, Fla., Univ. of Florida, 1968. 151p.

Thesis.

The neutron wave technique was used to study a heterogeneous system consisting of a natural uranium rod surrounded by a moderator of heavy water. By considering only a simple unit cell configuration, the theoretical derivations are simplified and one can perform a relatively simple and inexpensive experiment. The experimental technique applied permits the measurement of several heterogeneous parameters and can be used to study other fuel-moderator systems. The Feinberg-Galanin Constant, γ, was measured. This measurement was accomplished by first obtaining the experimental dispersion law for the unit cell. Next, the theoretical dispersion law is computed for various values of γ. The theoretical dispersion law best fitting the experimental one determines the value of γ. The theoretical model used is the Age-Diffusion Model. By using a series of transformations and an expansion in transverse eigen-functions, the two coupled equations are solved for the thermal flux. Inversion of the solution yields the theoretical dispersion law. This dispersion law is interesting in that a critical frequency is predicted at which the dispersion law for the unit cell is equal to that of the pure moderator. This intersection allows one to measure two other heterogeneous parameters of the group L_s, τ_{th}, η and p. The thermal neutron pulse, as a function of axial position, was numerically transformed from the time to the frequency domain. The frequency dependent attenuation constants and phase shifts were then obtained and the experimental dispersion laws were determined. The real and imaginary parts of the square of the complex inverse relaxation length were expanded in even and odd powers of the radian frequency. From the expansion coefficients γ was determined. However, it was found that more accurate results were obtainable when γ was determined from the dispersion law fit. Evaluation of p and τ_{th} results in unrealistic values for their quantities, indicating that a more accurate model than Age-Diffusion Theory is required for this analysis. Furthermore it is necessary to eliminate variations in heavy water purity to improve the accuracy of the experimental data. The analyses of this work have been conducted in the ρ plane. It appears that more accurate and sensitive results are obtainable when the analyses are conducted in the ρ^2 plane. Data to aid this type of future studies have been included. (Diss. Abstr.)

44812 EXPERIMENTAL DETERMINATION OF RESONANCE ABSORPTION CROSS SECTION FOR ZIRCALOY-2 AND ZIRCONIUM. Kocic, Antanasije; Markovic, Velimir. Bull. Boris Kidric Inst. Nucl. Sci., 19: Nucl. Eng., No. 2, 13-18(May 1968).

The integral absorption cross section for the reactor neutron spectrum and the thermal absorption cross section for zircaloy-2 have been determined using the pile oscillator technique. Using both values and a measured ratio of the epithermal to the thermal flux, the effective resonance integrals were obtained. After subtraction of the contributions for alloy and impurity elements, the effective resonance integrals for zirconium were evaluated. An extrapolated value of 0.91 ± 0.10(b) was obtained for the infinitely dilute integral. (auth)

44813 SLOW-NEUTRON SCATTERING BY MOLECULAR LIQUIDS. Agrawal, Ashok K. (Massachusetts Inst. of Tech., Cambridge. Argonne National Lab., Ill.); Yip, Sidney. Nucl. Sci. Eng., 37: 368-79(Sept. 1969).

The incoherent neutron scattering cross section of molecular liquids is evaluated using correlation function descriptions of molecular translations and rotations. The calculation is based on the Gaussian approximation for the intermediate scattering

function, and the analysis is specifically directed at the energy region of thermal and cold neutrons. Physical models are used to calculate the translational and rotational effects in the mean-square displacement (width) function, or equivalently, the generalized frequency distribution, and it is assumed that translation-rotation couplings can be ignored. The description of center-of-mass motions properly includes the short-time vibrations as well as the long-time diffusion. Different rotational models are discussed, and a simple expression is suggested which relates the rotational correlation function to the Fourier transform of a near infrared vibrational absorption band. Explicit calculations are carried out for liquid methane, and the results are in quite satisfactory agreement with both thermal- and cold-neutron measurements. The results also indicate that inelastic scattering effects are mostly due to rotational motions. Total cross sections are computed and found to agree with experiment (to within 3%) in the range $1-50\times10^{-3}$ eV. (auth)

44814 SOLUTION OF THE TRANSPORT EQUATION BY THE MONTE CARLO METHOD. Marquie, Mme (Laboratoire Central de l'Armement, Arcueil, France). Radioprotection, 4: 1-16 (1969). (In French).

The principles of the Monte Carlo method are indicated, and the essential elements of the method, including how to obtain a generator of uncertain numbers and how to improve the quality of the calculations by the choice of an estimator, are treated. One of the codes used at the Laboratoire Central de l'Armement to permit calculation of the transmission and reflection of a neutron flux in a semi-infinite media is developed; the results are compared with those obtained by two other methods: invariant dip and the method of moments. (tr-auth)

44815 ANALYSIS OF NEUTRON FOCUSING BY CONICAL TUBES AND ITS POSSIBLE APPLICATIONS. Shimooke, T. (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng., 37: 343-57(Sept. 1969).

The phenomenon of neutron focusing by a totally reflecting conical tube is studied in terms of the focused neutron currents, the spectrum shift, and the gains in beam intensity and in increasing the reaction rate of a 1/v absorber. The influence of the source temperature, the angular spread of the source flux, the geometrical variations of the conical pipe, and the reflectivity are considered. Two different approximate formulations on the focused neutrons in a reflecting tube are established for the purpose of carrying out the numerical calculations. The formulation allows detailed calculations on each order of multiple reflection, taking the tube geometry into consideration. The analysis shows that relatively strongly focused neutron currents are attainable under proper conditions by means of a "focalizer," a reflecting conical tube. The uses of a multistage focalizer are also suggested, showing examples where both intensity and a 1/v absorption rate in an exposed sample can be enhanced. (auth)

44816 THE NEUTRON SPECTRUM PRODUCED BY A PARAFFIN HOWITZER OPERATING WITH 14 MeV NEUTRONS. Ballard, T. D.; Cox, A. J. (Univ. of Aston, Birmingham, Eng.). Int. J. Appl. Radiat. Isotop., 20: 683-5(Sept. 1969).

A neutron "howitzer" is a device made of paraffin wax for producing an enhanced partially collimated flux of moderated neutrons and was developed at the University of Aston. In the work described it was used in conjunction with a source of 14 MeV neutrons. Many of the uses of the device, such as in neutron radiography and diffraction, require a knowledge of the neutron spectrum produced. Measurement of this spectrum between 10^{-2} and 10^{4} eV, using the neutron activation of material foils having strong resonances in their neutron capture cross sections is described. (auth) (UK)

44817 INVESTIGATIONS OF NEUTRON CAPTURE MECHANISM IN THE RESONANCE REGION. Gersch, Hans-Ulrich (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Fortschr. Phys., 17: 313-90(1969). (In German).

The neutron capture is a typical compound nuclear reaction. Nevertheless there are theoretical and experimental hints that the entrance channel and a few doorway states play an essential role in this reaction. It is possible to estimate the cross section for the channel capture characterized by the γ-emission of the entrance channel and γ-transitions to bound states of the product nucleus. The channel capture is composed by a smooth energy dependent part (potential capture) and a resonant part. A comparison with the total capture cross section yields conditions for a dominant channel part in the reaction. They are favored in the mass region $A \approx 60$ and $A \approx 200$, because there exist one-particle-p-states at low energies and, moreover, by the 3 s-giant resonance at $A \approx 60$. However, a dominant channel part of the capture cross section in the neighborhood of a neutron resonance is connected with a large neutron width. On the other hand it is necessary to look for small neutron widths and large distances of the resonances to investigate the potential capture between the resonances. The investigation of nuclides in these mass regions shows that the reactions $^{40}Ca(n,\gamma)$, $^{54}Fe(n,\gamma)$ and $^{206}Pb(n,\gamma)$ with thermal neutrons can be characterized by a large probability of channel capture. For a large number of other nuclides an essential participation of doorway states in the reaction must be concluded. However, further possibilities for a dominant channel capture are expected in many neutron resonances. The knowledge of wave functions of the target states and the excited states of the product nucleus makes it possible, at present, to study the mechanism of neutron capture in this most substantial phenomena. However, it would be desirable to develop effective theoretical methods for the practical calculations as well as to refine the experimental methods for the investigation of this reaction. (auth)

44818 RIEMANN–HILBERT BOUNDARY VALUE PROBLEM IN NEUTRON TRANSPORT THEORY. Boffi, Vinicio C.; Molinari, Vincenzo G. (Comitato Nazionale per l'Energia Nucleare, Bologna). Meccanica, 4: 100-8(June 1969).

A Riemann–Hilbert boundary value problem, occurring in neutron transport theory, is presented and solved for the case of an infinite straight line and zero index. (auth)

44819 NEUTRON-WAVE PROPAGATION IN CRYSTALLINE MODERATORS. IV. A TWO-GROUP STUDY. Kumar, Ashok (Dyal Singh Coll., New Delhi); Ahmed, F.; Kothari, L. S. Nucl. Sci. Eng., 37: 358-67(Sept. 1969).

A two-group study of neutron-wave propagation has been made in two crystalline moderators—beryllium and graphite. For each moderator the results are reported at two temperatures: (i) room temperature and (ii) a rather low temperature. The effect of Bragg cut-off on the propagation of neutron-waves in these crystalline moderators is clearly brought out. It is found that for frequencies greater than a certain frequency f_0, a pseudo-asymptotic mode exists even though cold neutrons fail to reach equilibrium. It is shown that in moderators at low temperatures, large phase difference between the two components of the wave (the cold neutrons and the rest) can develop for small source frequencies and this can lead to a considerable depression in the flux at some particular distance for some fairly well defined frequency. (auth)

44820 MONTE CARLO INTEGRATION OF THE ADJOINT NEUTRON TRANSPORT EQUATION. Eriksson, Bo (Industri-Matematik AB, Lidingoe, Sweden); Johansson, Claes; Leimdorfer, Martin; Kalos, M. H. Nucl. Sci. Eng., 37: 410-22(Sept. 1969).

The integral equation adjoint to the linear transport equation for neutrons is formulated and prescriptions are given for its solution by Monte Carlo methods. The process of tracking is the same as for the usual (i.e., forward) Monte Carlo and may be applied to complex geometry. On the other hand, the scattering process is determined by a kernel which is the transpose of the one used in the forward equation. With the help of suitably defined "adjoint cross sections" this transposed kernel may be written as a superposition of density functions for different reaction types in different nuclides. It is then possible to sample nuclide and reaction sequentially as in the familiar Monte Carlo for the forward process. Most emphasis is put upon the solution of the analytical and numerical problems which arise in calculating and sampling the probability distributions which determine these scattering processes. Detailed treatment is given for generating and using the requisite data for elastic scattering, for discrete and continuum inelastic neutron scattering and for (n,2n) reactions. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 44678, 44964, 45001, and 45006.

44821 HARMONIC-OSCILLATOR STATES AND THE α PARTICLE. I. FORM FACTOR FOR SYMMETRIC STATES IN CONFIGURATION SPACE. Aguilera-Navarro, V. C. (Univ. Nacional Autonoma de Mexico, Mexico City); Moshinsky, M.; Yeh, W. W. Ann. Phys. (N. Y.), 51: 312-36(Feb. 1, 1969).

Recent experiments on electron scattering by helium nuclei and the information they give on the form factor of the α particle suggest that the elementary gaussian distribution of charge in this nucleus must be modified. For this purpose the wavefunction of the α particle was expanded in terms of a complete set of non-spurious four-particle harmonic-oscillator states that are sym-

metric under the exchange of the nucleons and have orbital angular momentum zero. The latter states can be derived very easily in terms of a symmetric set of relative coordinates, and then transformed to Jacobi coordinates, for which the calculation of the form factor can be done in an elementary fashion. Numerical results are presented for an expansion of up to four quanta, showing that it is possible to find linear combinations of the harmonic-oscillator states which give a good fit to the experimental values. General procedures for getting the coefficients in the expansion both through a variational analysis of a possible Hamiltonian, and a least square fit to the experimental form factor are discussed. (auth)

44822 DISTORTION EFFECTS IN THE ELASTIC α-d-SCATTERING. Jacobs, H.; Wildermuth, K.; Wurster, E. J. (Univ., Tuebingen, Ger.). Phys. Lett., 29B: 455-7(July 21, 1969).

Variational calculations using trial functions which make explicit allowance for deuteron distortion are carried out for the s-wave of the elastic α-d-scattering. (auth)

44823 OBSERVATION OF THE ^{3}He(p,n)3p REACTION AT 25 MeV. Bacher, A. D.; Resmini, F. G.; Slobodrian, R. J.; de Swiniarski, R.; Meiner, H.; Tivol, W. M. (Univ. of California, Berkeley). Phys. Lett., 29B: 573-5(Aug. 4, 1969).

The neutron energy spectrum from the reaction ^{3}He(p,n)3p was measured at a laboratory angle of 8° for a proton bombarding energy of 24.9 MeV. A deviation of the spectrum shape from the prediction for four-body phase space was observed. (auth)

44824 A SEARCH FOR T = ½ RESONANCES IN p + ^{4}He ELASTIC SCATTERING. Bunker, S. N.; Cameron, J. M.; Epstein, M. B.; Paic, G.; Richardson, J. Reginald; Rogers, J. G.; Tomas, P.; Verba, J. W. (Univ. of California, Los Angeles). Nucl. Phys., A133: 537-44(1969).

The excitation function of the differential cross section of the ^{4}He(p,p)^{4}He reaction has been measured for the four laboratory angles 82.3, 92.3, 102.3, and 112.3° at incident proton energies between 22 and 46 MeV. A complete angular distribution for the ^{4}He(p,p)^{4}He reaction has been measured at 47 MeV incident energy. In addition excitation functions at laboratory angles of 23.5° and 70.0° were measured for the ^{4}He(p,d)^{3}He reaction between bombarding energies of 38.5 to 44.6 MeV. The investigation was undertaken to see if any T = ½ resonance effects exist in the p + ^{4}He compound system from possible "states" in ^{5}Li around 20, 22 and 25 MeV. No departure from a monotonic energy dependence can be discerned to within the accuracy of the individual experimental points. (auth)

44825 COMPILATION OF PRECISELY DETERMINED GAMMA-TRANSITION ENERGIES OF RADIONUCLIDES PRODUCED BY REACTOR IRRADIATION. Adams, F.; Dams, R. (Ghent Univ.). J. Radioanal. Chem., 3: 99-125(July 1969).

The gamma ray energies of nearly all radionuclides formed by reactor neutron irradiation were determined using high resolution Ge(Li) spectrometry. The reproducibility of the determinations is demonstrated and, to estimate the accuracy of the measurements, the results are compared with those of other investigators. In the energy range from 80 to about 1400 keV the accuracy for the most abundant gamma rays is better than 0.2 keV. The energies of gamma transitions above 1400 keV may be less accurate. The data are compiled in an atomic number and in a photon energy sequence. A table of characteristic x-rays is also included. The tables are intended to be helpful in the identification of isotopes in neutron activation analysis. (auth)

44826 PROTON SPECTRA FROM THE D(n,p)2n REACTION. Bond, Albert Haskell Jr. Madison, Wis., Univ. of Wisconsin, 1968. 117p.

Thesis.

Measurements of the proton spectra from the D(n,p)2n reaction were performed at neutron bombarding energies of about 8, 10, 13, 14, 23, and 28 MeV, in the forward direction, and a proton emission angle of 20° at bombarding energies of about 10 and 28 MeV. The D(d,n)^{3}He and T(d,n)^{4}He reactions produced monoenergetic neutrons for this reaction. The breakup protons from deuterium gas were detected in a counter telescope using solid-state E detectors at 8, 10, and 13 MeV bombarding energies. A CsI(Tl) crystal was used for an E detector at 14, 23, and 28 MeV bombarding energies. Absolute cross sections were determined from a comparison of the breakup proton yield with the elastic recoil proton yield obtained when the telescope cell was filled with hydrogen. The experimental results at bombarding energies of 13, 14, and 23 MeV agree with previous measurements at these energies, but the shape of the spectrum at 8 MeV differs somewhat from previous measurements at 8.4 MeV. The measurements were compared with the predictions of the Watson theory and the impulse approximation in forms given by R. J. N. Phillips. No attempt was made to fit the absolute cross sections. The theoretical distributions were calculated by computer, and resolution functions obtained from elastically scattered protons were folded into these distributions. The results were compared with the data by means of the maximum likelihood method of statistical analysis, with the n-n scattering length as the variable parameter. The analysis was performed above a cutoff proton energy determined by the goodness-of-fit of the data. For the Watson theory, values of a_{nn} were higher than would be expected at bombarding energies of 8, 10, 13, and 14 MeV. At bombarding energies of 23 and 28 MeV, the Watson theory did not give a reasonable fit for any value of a_{nn}. For the impulse approximation, fits to the data were made at all bombarding energies. The statistically weighted average of the results of the impulse approximation gave $a_{nn} = -16.8 \pm 1.0$ fm. The scatter of the results at different energies about this point is consistent with a constant value for a_{nn}, except possibly for the value $a_{nn} = -23^{+3}_{-4}$ fm at 8 MeV bombarding energy. Excluding this point, the average becomes $a_{nn} = -15.9 \pm 1.1$ fm. Either average is consistent with the theoretical calculations of Heller et al., and with the work of Haddock et al., on the D(π^-,γ)2n reaction and the work of Bar-Avraham et al., on the D(n,p)2n reaction at 13.9 MeV, using the impulse approximation. The values of a_{nn} obtained in the present work using the impulse approximation tend to be lower than values obtained previously using various other analyses. (Disser. Abstr.)

44827 NEUTRON–HELIUM SCATTERING AT NEUTRON ENERGIES BELOW 1 MeV. Cramer, Douglas Scott. Charlottesville, Va., Univ. of Virginia, 1968. 127p.

Thesis.

^{4}He was pressurized to 303 atmospheres in a spherical vessel. Relative differential cross sections for the scattering of neutrons from helium were measured at neutron energies of 0.545 and 0.840 MeV and normalized to the total cross sections. Phase shifts were deduced and found to be in agreement with values recently published. This permitted greater confidence below 1 MeV in the phase shifts which parameterize the polarizing (analyzing) power of ^{4}He. The helium-filled vessel was subsequently employed to analyze the polarization of the neutrons from the T(p,n)^{3}He reaction at 31.6° in the laboratory (45° in the center of mass). Data were taken at six proton energies ranging from 1.3 to 2.3 MeV which produced neutrons at 31.6° with corresponding energies from 0.38 to 1.3 MeV. The present results overlap with the previous measurements at proton energies above 2.0 MeV and are in agreement with a neutron polarization of 0.40 ± 0.04 for a proton energy of 2.2 MeV and corresponding neutron energy of 1.2 MeV at 31.6°. This large value for the polarization and the high flux of neutrons that are available from the T(p,n) reaction can be used to study the spin-orbit dependence of many neutron scattering processes. For the T(p,n) reaction, the theorists attribute the polarization at these low energies to the interference of the $^3P_2$ and $^3P_0$ waves forming the T = 0; $J^\pi = 0^-$, 2^- states in ^{4}He at 21.4 and 22.4 MeV, respectively. The present measurements are larger than those predicted from the theory and consequently, indicate a needed adjustment of the spacing and position of the above levels. Most probably the spacing will be decreased to increase the interference and resulting polarization. (Disser. Abstr.)

44828 PHOTOPRODUCTION OF π^0 MESONS ON THE ^{4}He NUCLEUS. Gur'ev, V. N. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 910-12(June 1969). (In Russian).

The numerical values of the differential cross sections for the coherent photoproduction of π^0-mesons on the ^{4}He nucleus in the photon energy range 160 to 450 MeV and the meson cm angles 10 to 140° are obtained in approximation, when only the first anomalous singularity in the momentum transfer connected with the triangle diagram is taken into account and the form factor of the ^{4}He nucleus corresponds to the Gaussian distribution with the rms radius equal to 1.4°F. The obtained results are in good agreement with the experiment at the photon energy range 160 to 210 MeV and cm angles 80 to 90° for the mesons. Analogous calculations were also made at the angle 90° with the rms radii 1.61°F and 1.7°F. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 43291, 44040, 44678, 44825, 44877, 44890, and 44964.

44829 (CEA-R-3727) ELASTIC AND INELASTIC SCATTERING OF 2 TO 10 MeV PROTONS BY LITHIUM ISOTOPES. Laurat, Michel (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). May 1969. 78p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

A description is given of the experimental setup which was devised for carrying out spectrometric and absolute cross-section measurements on the reactions induced by protons accelerated in a 12-MeV Van de Graaff tandem. The particles are detected by silicon junctions; the weight of the targets (about ten $\mu g/cm^2$) is determined by the quartz method. The experimental equipment was controlled by a study of proton scattering by ^6Li. The elastic and inelastic scattering (1st level excitation) by ^7Li of 2- to 9-MeV protons was studied. The most probable spin and parity values for the six levels of ^8Be between 19 and 25 MeV excitation energy were determined from a knowledge of the observed structure. (auth)

44830 (WANL-TME-1920) NEW CROSS SECTIONS FOR GAM, TNS, AND BIT LIBRARIES. Schneider, M. J. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Apr. 15, 1969. Subcontract SNP-1. 74p. Dep. CFSTI.

Additions and changes in the neutron cross sections for the GAM, TNS, and BIT libraries are reported. (J.W.R.)

44831 MEASUREMENT AND ANALYSIS OF $^{16}O(p,\gamma)^{19}F$ RESONANCES. Dunning, Kenneth Laverne. Washington, D. C. Catholic Univ. of America, 1968. 132p.

The yields from four resonances in the $^{16}O(p,\gamma)^{19}F$ reaction were determined with the proton beam from a Van de Graaff accelerator after it had passed through a magnetic analyzer and a two-meter electrostatic analyzer. The average beam energy was known to within a few parts in 10^4 and its energy spread was about .02% at half maximum. Resonance energies of 629.6 ± 0.3, 116.5 ± 0.4, 1928.4 ± 0.6 and 2263.0 ± 0.7 keV were measured. The total widths of the resonances were found to be 2.0 ± 0.3, 0.025 ± 0.024, 0.3 ± 0.05, and 5.0 ± 1.0 keV respectively. Fortran programs were developed for numerical analysis of the yield curves. The yield formula used is an integral over the single-level Breit-Wigner cross section, the beam energy distribution and an energy loss distribution given by the theory of P. W. Vavilov. The theory was tested on published data for the 992 4-keV $^{27}Al(p,\gamma)^{28}Si$ resonance and found to be in good agreement with the predictions of a yield formula based on the energy loss theory of K. Symon. The prediction of Vavilov's theory did not give good agreement with the experimental yields from Ta_2O_5 targets but modification of a parameter in the theory led to agreement. This parameter, the number of electrons per target molecule, was reduced. The agreement of the unmodified theory with respect to $^{27}Al(p,\gamma)^{28}Si$ data and not with the $^{16}O(p,\gamma)^{19}F$ data is attributed to the higher atomic number of the tantalum of the $Ta_2{}^{16}O_5$ targets relative to the atomic number of aluminum and the nature of an approximation made in the development of the Vavilov energy loss formula. The isobaric spin impurity amplitude of the $T = \frac{3}{2}$ state in ^{19}F at an excitation energy of 9.1 MeV was re-estimated to be $\alpha_{\frac{3}{2}}(\frac{1}{2}) = 1.6 \times 10^{-2}$ on the basis of the new width determination of the 1166.5-keV resonance. (Diss. Abstr.)

44832 INFORMATION ON ^{11}Be FROM MUON-CAPTURE MEASUREMENTS. Deutsch, J. P.; Grenacs, L.; Lehmann, J.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). pp 325-9 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

A Ge(Li) detector was used to measure the γ spectra from negative muon capture in ^{11}B. The implications of the results on the spin-parity assignments of the ground and excited states of ^{11}Be are discussed. (J.W.R.)

44833 PRELIMINARY NOTE ON PARTIAL MUON-CAPTURE RATE MEASUREMENTS IN ^{16}O. Deutsch, J. P.; Grenacs, L.; Lehmann, J.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belg.). pp 330-3 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

A Ge(Li) detector was used to measure the γ spectra from negative muon capture in ^{16}O. The capture rates to excited states in ^{16}N were determined. (J.W.R.)

44834 MUON CAPTURE IN ^{12}C AND NUCLEAR STRUCTURE. Hirooka, Masahiko (Osaka Univ.); Konishi, Teruaki; Morita, Reiko; Narumi, Hajime; Soga, Michitoshi; Morita, Masato. pp 334-8 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The muon capture rate in ^{12}C was calculated without using the normalization constant obtained from ^{12}B beta decay. General p-shell wave functions with configuration mixing parameters derived from the dynamical properties of A = 12 systems were used. The value obtained is in reasonable agreement with other calculations. (J.W.R.)

44835 INTERNAL BREMSSTRAHLUNG IN THE SUPERALLOWED DECAY OF THE CLEAR POSITRON EMITTER ^{11}C. Berenyi, D.; Scharbert, T.; Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). pp 170-5 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The internal bremsstrahlung spectrum of the superallowed positron decay of ^{12}C was studied in a $\beta-\gamma$ coincidence arrangement. There was fairly good agreement between the experimental spectra and calculations according to KUB theory. (J.W.R.)

44836 STUDY OF $T = \frac{3}{2}$ STATES IN ^{13}N. LeVine, Michael Joseph. New Haven, Yale Univ., 1968. 123p.

Thesis.

A study of $T = \frac{3}{2}$ states in ^{13}N was carried out by observing these states as resonances in the compound system $^{12}C + p$. The lowest $T = \frac{3}{2}$ state was observed as a resonance in the proton elastic scattering at $E_p = 14.231 \pm 0.006$ MeV. A search for additional $T = \frac{3}{2}$ states was carried out by measuring excitation functions for elastic scattering and for several proton-induced reactions over the energy range from 17.0 to 21.5 MeV; two anomalies were found whose widths and locations suggest that they might be $T = \frac{3}{2}$ states; at 17.80 and 18.459 MeV. In order to obtain the spins and parities of these states as well as to extract the elastic partial widths for the resonances a program of phase shift analysis was carried out. Eight resonances were analyzed including the three which are thought to correspond to $T = \frac{3}{2}$ states in ^{13}N. The analysis of the 14.231 MeV resonance yielded $J^\pi = \frac{3}{2}^-$. For the 17.80-MeV resonance $J^\pi = \frac{3}{2}^+$, and the 18.459-MeV resonance was found to have a spin and parity $\frac{3}{2}^-$ or $\frac{1}{2}^+$. The two narrow resonances at 17.80 and 18.459 MeV are identified as $T = \frac{3}{2}$ states on the basis of their widths and locations. Both the spins and parities determined for these resonances and the strength with which the protons decay to the 15.11-MeV states in ^{12}C are consistent with this identification. (Disser. Abstr.)

44837 MEASUREMENT OF THE NUCLEAR MAGNETIC MOMENT OF THE ISOTOPE ^{12}B. Wells, John Calhoun Jr. Baltimore, Johns Hopkins Univ., 1968. 91p.

Thesis.

Measurements of both nuclear magnetic resonance frequencies and spin relaxation times were made on polarized ^{12}B nuclei implanted in various metals. Polarized ^{12}B recoils are produced by a $^{11}B(d,p)^{12}B$ reaction, the polarization being preserved by implantation in suitable metals, and measured by observing the asymmetric β emission pattern. Low field precession measurements were performed in order to obtain an approximate value of the ^{12}B magnetic moment. Very precise measurements of the magnetic moment were obtained by resonant destruction of the polarization with a transverse rf magnetic field. The ^{12}B magnetic moment, uncorrected for the Knight shift, is found to be $\mu = (1.00334 \pm 0.00005)$ nm for implantation in gold, (1.00261 ± 0.00006) nm for implantation in platinum, and $(1.00253 + 0.00005)$ nm for implantation in palladium. Spin relaxation times T_1 of ^{12}B nuclei in Au, Pt, and Pd were obtained for temperatures T between 130 and 600°K, and at fields up to 2.3 kG, by observing the ^{12}B polarization as a function of time. The product T_1T is found to be approximately constant over a large range of temperatures. $T_1T = (45 \pm 4)$ sec °K for Au, (257 ± 36) sec °K for Pt, and (144 ± 10) sec °K for Pd. Values of the Knight shifts of ^{12}B nuclei in these metals are computed from T_1T using the Korringa relation. These values are used to correct the nuclear magnetic resonance measurements. The final corrected value of the ^{12}B magnetic moment is $\mu = (1.00189 \pm 0.00015)$ nm. Applications of the recoil polarization technique are discussed, and experiments are proposed for using this technique for measuring nuclear electric quadrupole moments. (Disser. Abstr.)

44838 FIRST ORDER ANALYSIS OF THE REACTION ^6Li $(p,p\alpha)d$. Nagatani, K. (Brookhaven National Lab., Upton N. Y.). Phys. Lett., 29B: 468-72(July 21, 1969).

The reaction ^{6}Li(p,pα)d was investigated by a PWBA calculation, including all exchange processes with finite range interactions. The distortion effects are discussed for the α knockout term. It was found that at the angular configurations where the recoil deuteron momenta are small, the direct terms dominate and the exchange terms are extremely small. It was also found that the overall spectrum shapes are most sensitive to the form of the relative wave function of the (pn)- and α clusters in the ^{6}Li nucleus. (auth)

44839 HYPERFINE STRUCTURE SEPARATIONS IN THE GROUND STATE MULTIPLET OF THE STABLE CARBON ISOTOPE ^{13}C. Wolber, G.; Figger, H.; Haberstroh, R. A.; Penselin, S. (Univ., Bonn). Phys. Lett., 29A: 461-2(June 30, 1969).

The hyperfine structure separations F = ½ ⟷ ³/₂ and ³/₂ ⟷ ½ in the $2p^2$ $^{3}P_2$ and $^{3}P_1$ states, respectively, of ^{13}C were measured with the atomic beam magnetic resonance method. A combination of these data with other measurements yields −0.964(1) nm for the nuclear magnetic dipole moment of ^{11}C. (auth)

44840 MUON CAPTURE IN ^{11}B AND NUCLEAR WAVE FUNCTIONS OF ^{11}Be. Bernabeu, J.; Pascual, P. (Univ., Valencia). Phys. Lett., 29B: 555-7(Aug. 4, 1969).

Muon capture rates in ^{11}B going to ^{11}Be (g.s.) and ^{11}Be* (320 keV) as well as the electromagnetic transition rate for $^{11}Be^{*} \rightarrow {}^{11}Be + \gamma$ are computed in order to obtain information on the ^{11}Be nuclear wave functions. The hyperfine muon capture rates to ^{11}Be* are also calculated. (auth)

44841 COMPARISON OF EFFECTIVE INTERACTIONS IN NUCLEAR STRUCTURE AND SCATTERING. Schmittroth, Frank Alan. Corvallis, Oreg., Oregon State Univ., 1969. 147p.

Thesis.

Effective two-body potentials were studied for nuclei in the 2s-1d shell and the 1p shell via both structure and scattering calculations. The potential included a central Yukawa force with arbitrary exchange and a tensor force. Calculations were done by use of potential multipole expansions which allow the use of bound single-particle states computed in a Woods-Saxon well. Effective potential strengths were obtained for nuclear structure by the application of a least squares criterion to effective two-body matrix elements currently available in the literature for the 1p and 2s-1d shells. The prominent features of the potential obtained in this way were strong attractive even strengths and weak repulsive odd strengths. These results were consistent between the two shells. The strength of the tensor force, however, was not given consistently. DWBA calculations which included a tensor force were carried out for the following reactions: ^{14}C(p,n), ^{15}N(p,n), ^{17}O(p,n), ^{18}O(p,n), ^{14}N(p,p'), and ^{14}C(^{3}He,t). For the ^{14}C(p,n) ground state transition and the analogous (p,p') reaction in ^{14}N, the tensor force produced a marked improvement in the fit to the experimental angular distributions and total cross sections. No improvement was found, however, for the (^{3}He,t) calculation for the same transition, a case poorly fit by the central force calculations also. No significant change was noted in the other reactions. The effective strengths that were deduced from fitting effective matrix elements were compared to values obtained from DWBA calculations. Exchange calculations (knockout) were made for ^{14}C(p,n) and ^{18}O(p,n) reactions. The exchange contributions were not large but were quite significant. In particular, they produced an increase in the effective even strengths and a reduction of the effective odd strengths. As a result, a marked improvement in the value of V_{00} is obtained when compared to structure studies. A discrepancy still exists; however, it is thought that core-polarization can remove most of it. Finally a coupled channel calculation was done for the $^{14}C-{}^{14}N$ system based on a microscopic model with charge exchange. The results confirmed the validity of the DWBA calculations. (Diss. Abstr.)

44842 ANALYSIS OF ANGULAR DISTRIBUTIONS OF DEUTERONS AND TRITONS IN LITHIUM-INDUCED REACTIONS. Davydov, V. V.; Pavlichenkov, I. M. (Inst. of Atomic Energy, Moscow). Phys. Lett., 29B: 551-4(Aug. 4, 1969).

A simple mechanism for the (^{6}Li,d) and (^{7}Li,t) reactions with the excitation of rotational bands in ^{16}O and ^{20}Ne is proposed. It is shown that agreement with the experimental angular distributions is much better for the (^{7}Li,t) reactions than for the (^{6}Li,d). (auth)

44843 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE E1-ELECTROEXCITATION OF THE 3.08 MeV LEVEL IN ^{12}C. Tomaselli, M.; Gruenbaum, L.; Beer, G. A.; Clerc, H.-G.; Wittwer, G. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 29B: 579-80(Aug. 4, 1969).

Inelastic electron scattering experiments at momentum transfers $q < 0.6$ fm^{-1} have revealed a large transverse cross section. A theoretical explanation of the experimental results is given on the basis of the particle-core coupling model. (auth)

44844 CHARGE EXCHANGE IN NUCLEI FOLLOWING PION INELASTIC SCATTERING. Hewson, P. W. (Oxford Univ.). Nucl. Phys., A133: 659-72(1969).

The effect of the inclusion of an isospin dependent term in the nuclear optical potential which can then cause charge exchange has been considered. An experiment determined the ratio, R, for positive to negative pions of ^{11}C production from the interaction of 180 MeV pions with ^{12}C, to be unity. There is a major discrepancy between this result and that predicted by a simple impulse approximation which gives a ratio of R = 3. The inclusion of charge exchange in a nuclear final state interaction has reduced the ratio R to less than 2. (auth)

44845 ^{13}N, ^{11}C, AND ^{18}F ISOTOPE YIELDS UNDER CHARGED PARTICLE IRRADIATION OF CARBON AND OXYGEN. Krasnov, N. N.; Dmitriev, P. P.; Dmitrieva, Z. P.; Konstantinov, I. O.; Molin, G. A. At. Energ. (USSR), 27: 125-8(Aug. 1969). (In Russian).

Methods of measurements and experimental data of ^{13}N, ^{11}C, ^{18}F yield dependence upon the bombarding particle energy obtained by irradiation of oxygen and carbon are presented. Protons (22 MeV), deuterons (22 MeV), ^{3}He ions (30 MeV) and α-particles (44 MeV) were used for the irradiation. The values of the yields obtained allow to determine carbon and oxygen admixtures by the absolute method. (auth)

44846 EXCITATION OF ONE-PARTICLE LEVELS OF NUCLEI ^{7}Li AND ^{7}Be AT INELASTIC ELECTRON SCATTERING. Tartakovskii, V. K.; Fursaev, A. V. (Kiev State Univ.). Ukr. Fiz. Zh., 14: 895-903(June 1969). (In Russian).

The inelastic scattering of high-energy electrons by light nuclei with excitation of the one-particle states of the nuclei was studied. The nuclei are described in the independent particle model with L-S coupling. The differential cross sections for excitation of low-lying levels of mirror nuclei ^{7}Li and ^{7}Be were obtained. Low-energy states for ^{7}Li and ^{7}Be are described well in the scheme of L-S coupling. The contributions of transverse electric and magnetic multipoles are taken into account together with the contribution of the longitudinal Coulomb multipoles. The comparison of calculated angular distributions of inelastically scattered electrons with the experimental data gives possibility to check the applicability of used nuclear models. It may also give new information on some nuclear states. (auth)

44847 SHELL-MODEL CALCULATION FOR THE REACTION ^{15}N(p,n)^{15}O. Hanna, John Stewart. Cleveland, Case Western Reserve Univ., 1968. 105p.

Thesis.

The unified theory of Feshbach is applied to the reaction ^{15}N(p,n)^{15}O. Two open channels, for the elastically scattered proton and the inelastically scattered neutron, are explicitly included. The open channels are coupled by the optical isobaric spin dependent potential of Lane. The closed channel Hamiltonian is diagonalized in a restricted shell model basis of one-particle one-hole negative parity states; the positions and widths of the resonances in ^{16}O due to the closed channels are compared with experiment. The total neutron cross section and angular distributions are also compared with experiment. Some differential excitation functions are presented for the elastically scattered proton. Viewed within the context of the rather simple model chosen, the agreement between experiment and theory is encouraging. Some of the more important shortcomings are discussed and improvements are suggested. (Disser. Abstr.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 43291, 43565, 43577, 43582, 44614, 44678, 44758, 44825, 44830, 44842, 44882, 44907, 44911, 44964, 44972, and 45002.

44848 (AECL-3333) PHYSICS DIVISION PROGRESS REPORT, JANUARY 1, 1969–MARCH 31, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 87p. Dep. CFSTI. CAN $2.00.

COBALT-60—beta decay of, half-life for, (E)
GERMANIUM-70—energy levels of, transition probabilities for, (E)
INDIUM-115—neutron capture by, γ-ray energies and intensities for resonance
IODINE-127—energy levels from oxygen-16 Coulomb excitation, spin-parity assignt for, (E)
MANGANESE-56—beta decay of, half-life for, (E)
NEUTRONS, EPITHERMAL—capture by indium-115, γ-ray energies and intensities for

NICKEL-58—energy levels from nickel-60 (p,t) reactions, shell-model calculation for, (T)
—energy levels from proton inelastic scattering, lifetimes for, (E)
NICKEL-60—energy levels from nickel-62 (p,t) reactions, shell-model calculation for, (T)
NICKEL-62—energy level of, quadrupole moment of first excited, (E)
—energy levels from nickel-64 (p,t) reactions, shell-model calculation for, (T)
PALLADIUM-105—energy levels from oxygen-16 Coulomb excitation, (E)
SCANDIUM-43—energy levels from calcium-40 (α,pγ) reactions, spin-parity assignments for, (E)
SILICON-28—energy level at 1.779 MeV, static quadrupole moment of, (E)
SULFUR-32—energy levels and transitions from α inelastic scattering, (E)
—energy levels from proton inelastic scattering, lifetimes for, (E) (J.W.R.)

44849 (IN-1130) GAMMA-RAY SPECTROMETRY OF NEUTRON-DEFICIENT ISOTOPES. Annual Progress Report. Cline, J. E.; Heath, R. L. (Idaho Nuclear Corp., Idaho Falls). May 1969. Contract AT(10-1)-1230. 84p. Dep. CFSTI.

The primary objective of this program was to produce neutron-deficient nuclides to obtain high-resolution gamma-ray spectra and basic information on gamma-ray branching ratios, gamma-ray energies, and intensities for the Gamma-ray Spectrum Catalogue. The emphasis in this effort is to provide nuclear laboratories and experimenters with these data obtained with state-of-the-art gamma-ray spectrometers. To make this information most useful, standard methods for obtaining and analyzing data obtained with Ge(Li) spectrometers are being developed. Neutron-deficient nuclides were produced primarily by proton bombardment of target materials using (p,xn) reactions and by (n,p) and (n,α) reactions using fast neutrons. Spectra were obtained for approximately 30 nuclides. Data on these nuclides include precise energies and intensities for the primary gamma rays. Considerable effort was also made in the study of the operating characteristics of standard laboratory spectrometers. Systematic studies were made of the detection efficiency of Ge(Li) detectors for gamma rays up to 10 MeV. Such data are designed to provide criteria for the selection of detectors to fill particular experimental needs. As an extension of these studies, a number of specialized detector systems were investigated. Preliminary measurements of the operating characteristics of a two-crystal Compton summing spectrometer have been completed. Data obtained indicate that such systems offer considerable promise in the reduction of the unwanted Compton continuum in pulse-height spectra. In the interest of improving the performance of high-resolution Ge(Li) spectrometers, pulse rise-time systems for rejecting unwanted pulses resulting from charge collection problems in these detectors were evaluated. The development of electronic circuitry and study of problems in spectrometers which lead to degradation in performance at high counting rates have also received considerable attention. (auth)

44850 (N-69-24919) STUDY OF THE (α,t) REACTION ON ^{45}Sc AT 41 MeV. Priest, Joseph R.; Vincent, John S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 28p. (NASA-TN-D-5216). CFSTI.

Thirteen angular distributions were measured from 8 to 70° for the ^{45}Sc(α,t)^{46}Ti reaction at 41 MeV. All exhibit the same basic shape, which is consistent with a distorted wave calculation where three units of angular momentum are transferred. Relative spectroscopic strengths for these transitions agree well with experimental values obtained by others for the (^{3}He,d) reaction. Good overall agreement is obtained in a comparison with spectroscopic factors calculated from the McMullen, Bayman, and Zamick model for ^{45}Sc and ^{46}Ti. (auth) (STAR)

44851 (UCRL-71828) PHOTONEUTRON CROSS SECTIONS OF ^{24}Mg AND ^{26}Mg. Fultz, S. C.; Berman, B. L.; Caldwell, J. T.; Kelly, M. A.; Harvey, R. R. (California Univ., Livermore. Lawrence Radiation Lab.). June 27, 1969. 8p. (CONF-690816-5). Dep. CFSTI.

From Gordon Conference for Photonuclear Reactions, Tilton, N. H.

Photoneutron cross sections for ^{24}Mg and ^{26}Mg were measured as a function of photon energy from about 11 to 28 MeV. (B.G.D.)

44852 MULTIWIRE PROPORTIONAL COUNTER STUDIES TO DETERMINE THE M/L ORBITAL ELECTRON CAPTURE RATIO IN ^{71}Ge DECAY. Genz, H. (Georgia Inst. of Tech., Atlanta). pp 81-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. (ORO-3346-22).

See CONF-680703-(Vol.1).

Additional precision measurements of M/L orbital electron capture ratios for allowed transitions are needed to check theoretical calculations, since recent experiments (e.g., ^{37}Ar) establish a substantial disagreement with exchange-corrected theory based on the Watson-Freeman Hartree-Fock wave functions. For this reason, an investigation of the M/L capture ratio in ^{71}Ge decay is in progress, using the gaseous compound $^{71}GeH_4$ in a wall-less multiwire proportional counter filled with argon-propane mixtures at pressures up to 6 atmospheres. The fully transistorized electron system includes a special logic unit with zero-time recovery (updating) to perform the following operations: (a) to ensure proper anticoincidence functioning of the ring counter; (b) to provide paralysis pulses necessary to block possible afterpulses following an ionizing event; and (c) to eliminate the phenomenon of front- and back-edge clipping of large pulses into small ones by the action of the anticoincidence gate. All of the discriminators and gates in the electronic system have zero-time recovery. The special logic unit and the zero-time recovery (updating) feature of the electronic system are absolutely necessary, especially for precision measurements in the low energy region ($\leq \approx 200$ eV). The ^{71}Ge studies in progress will be discussed and compared with current theoretical predictions; a very preliminary value is M/L = 0.151 ± 0.015. (auth)

44853 EXPERIMENTAL ASPECTS AND COMPARISONS WITH THEORY OF ORBITAL ELECTRON CAPTURE RATIOS. Fink, R. W. (Georgia Inst. of Tech., Atlanta). pp 23-44 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. (ORO-3346-21).

See CONF-680703-(Vol.1).

Recent improvements in experimental techniques for measurement of M/L and L/K capture ratios are surveyed, and the required accuracy for critical comparisons with theoretical calculations is discussed. Examples of recent investigations which illustrate various improved methods and results are discussed. Examples of recent investigations which illustrate various improved methods and results are discussed (e.g., ^{37}Ar, ^{40}K, ^{125}I, ^{185}Os, ^{194}Hg). Nuclides of interest for further investigations are suggested, together with discussion of source preparation and suitable experimental methods. A need is indicated for accurate measurements of forbidden electron capture transitions, and for theoretical calculations of the effect of forbiddenness on the Bahcall exchange correction. Current work on forbidden transitions is discussed (e.g., ^{59}Ni, ^{81}Kr, ^{205}Pb). For second-forbidden nonunique ($\Delta I = 2$, no) electron capture transitions (e.g., ^{36}Cl, ^{53}Mn, ^{59}Ni, ^{91}^{g}Nb, ^{93}^{g}Mo, ^{97}^{g}Tc), absolute values of the nuclear matrix elements can be evaluated when both the M/L and L/K ratios and Q_{EC} are known from experiment, as pointed out by Hubbard. Available precision values of M/L and L/K capture ratios are compared critically with theoretical calculations, both with and without correction for electron exchange calculated by Bahcall. The disagreement between experiment and exchange-corrected theory is larger for M/L- than for L/K-ratios for allowed transitions: The theoretical values, based on the Watson-Freeman Hartree-Fock wave functions, are systematically high. The origin of these disagreements may lie with the screening assumptions. Several new calculations of accurate analytical SCF Hartree-Fock wave functions in the low-Z region have been reported recently from which the capture ratios should be calculated to determine whether better agreement can be achieved. (auth)

44854 PROCEEDINGS OF THE CONFERENCE ON THE ELECTRON CAPTURE AND HIGHER ORDER PROCESSES IN NUCLEAR DECAYS, DEBRECEN, HUNGARY, JULY 15-18, 1968. VOLUME 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. 141p. (CONF-680703-(Vol.1)).

Separate abstracts were prepared for the 16 papers included in this volume. (J.W.R.)

For abstracts of individual papers see: 43522, 43568, 43569, 44852, 44853, 44893-44896, and 44957-44963.

44855 MEASUREMENT OF THE ϵ/β^+ RATIO OF THE $2^- \rightarrow 2^+$ TRANSITION OF ^{74}As. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary); Varga, D.; Uchrin, J. pp 258-62 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-

18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol. 2).

Scintillation counters were used to measure the electron-capture to positron emission ratio for the $2^- \rightarrow 2^+$ transition in ^{74}As. (J.W.R.)

44856 ON THE DECAY OF ^{58}Co. Bambynek, W.; De Roost, E.; Funck, E. (EURATOM, Geel, Belg.). pp 253-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

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The K x-ray and positron emission rates for ^{58}Co were determined with an NaI(Tl) spectrometer. The results were checked by a 4π coincidence system and with a calibrated Ge(Li) spectrometer. The intensities of the γ rays from ^{58}Co were determined with the Ge(Li) detector. (J.W.R.)

44857 AN ANALYSIS OF ^{36}Cl DECAY POSITRON BRANCH. Zyryanova, L. N.; Nikolaev, K. N. (Leningrad State Univ.). pp 244-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The L/K and K/β^+ values for the decay of ^{36}Cl were calculated for various values of the nuclear parameters. (J.W.R.)

44858 A STUDY OF THE INTERNAL BREMSSTRAHLUNG FROM ^{32}P BY MAGNETIC DEFLECTION OF THE DIRECT ELECTRONS. Berenyi, D.; Varga, D. (Inst. of Nuclear Research, Debrecen, Hungary). pp 176-81 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

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The internal bremsstrahlung accompanying the β decay of ^{32}P was studied using magnetic deflection to prevent β particles from reaching the counter and producing external bremsstrahlung. The experiment was also performed with a beta absorber and the magnetic pole pieces removed. The results were compared with Coulomb corrected KUB calculations. (J.W.R.)

44859 MEASUREMENTS OF THE INTERNAL BREMSSTRAHLUNG OF ^{32}P, ^{90}Y, AND ^{90}Sr. Loos, G.; Kreische, W.; Lampert, W.; Trebst, H. J. (Univ., Erlangen, Ger.). pp 182-6 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The internal bremsstrahlung spectra accompanying the beta decays of ^{32}P, ^{90}Sr, and ^{90}Y were studied. The results were compared with KUB theory and Lewis-Ford theory. (J.W.R.)

44860 INTERNAL BREMSSTRAHLUNG ACCOMPANYING THE POSITRON DECAY OF ^{82}Rb. Akselsson, R. (Lund Inst. of Tech., Sweden); Persson, B. pp 187-91 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The internal bremsstrahlung accompanying the β^+ decay of ^{82}Rb using an experimental arrangement designed to eliminate annihilation-in-flight contributions. (J.W.R.)

44861 ELECTRON CAPTURE AND POSITRON DECAY OF ^{57}Ni TO LEVELS OF ^{57}Co. Gatrousis, C.; Meyer, R. A.; Mann, L. G. (Univ. of California, Livermore). pp 453-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The decay of 36.0-h ^{57}Ni produced by the ^{54}Fe(α,n)^{57}Ni reaction was studied to obtain information on the level structure of ^{57}Co. Gamma ray spectra were obtained with high-resolution Ge(Li) detectors, a Compton suppressed Ge(Li) system, and Ge(Li)-NaI(Tl) γ-γ coincidence spectroscopy. The γ-ray energies in keV (and the relative photon intensities) observed are as follows: 127.1 ± 0.1(200), 161.8 ± 0.3(0.22), 252.5 ± 0.6(≤0.4), 380.0 ± 0.2(0.96), 673.4 ± 0.2(0.58), 906.8 ± 0.3(1.1), 1046.4 ± 0.2(1.6), 1223.5 ± 0.4(1.1), 1377.6 ± 0.2(1000), 1730.6 ± 0.3(0.72), 1757.6 ± 0.2(77), 1896.5 ± 0.4(0.28), 1919.5 ± 0.2(170), 2132.9 ± 0.3(0.47), 2730.6 ± 0.2(0.3), 2803.9 ± 0.2(1.7), 3176.9 ± 0.3(0.24). On the basis of Ge(Li)-NaI(Tl) coincidence experiments, energy sums, and earlier nuclear reaction data, levels in ^{57}Co were assigned at 0($\frac{7}{2}^-$), 1223.5 ± 0.4($\frac{3}{2}^-$), 1377.6 ± 0.2($\frac{1}{2}^-$), 1504.7 ± 0.2($\frac{1}{2}^-$), 1757.6 ± 0.2($\frac{3}{2}^-$), 1896.5 ± 0.4($\frac{1}{2}^-$), 1919.5 ± 0.2($\frac{5}{2}^-$), 2132.9 ± 0.3($\frac{5}{2}^-$), 2730.6 ± 0.2($\frac{5}{2}^-$, $\frac{3}{2}^-$), 2803.9 ± 0.2 ($\frac{3}{2}^-$, $\frac{5}{2}^-$), 3108.2(≤$\frac{5}{2}^-$), and 3176.9 ± 0.3($\frac{5}{2}^-$) keV. The spin assignments are based on data from nuclear reaction studies, log ft values and relative gamma ray intensities. An attempt was made to explain the experimental results and the structure of ^{57}Co in terms of single-particle states and particle-plus-core states based on coupling the 2+ collective core vibration to the $f_{7/2}$ odd proton. Previous work on ^{57}Co and ^{59}Co indicates that levels in ^{57}Co at 1223.5($\frac{3}{2}^-$), 1683($\frac{11}{2}^-$), 1757.6 ($\frac{3}{2}^-$) and 2132.9($\frac{5}{2}^-$) keV belong to a core-coupled multiplet. Gamma-ray branching ratios are in agreement with this characterization of the states at 1223.5 and 1757.6 keV. (auth)

44862 HALF-LIFE ALTERATIONS PRODUCED BY CHEMICAL MEANS IN ELECTRON-CAPTURE DECAYING ^{64}Cu. Kemeny, P. (Inst. for Atomic Physics, Bucharest). pp 432-6 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

Half-life measurements were made for the electron-capture decay of ^{64}Cu using three different sources in order to check for half-life variations due to chemical effects. Measurements were made for metallic copper, $CuSO_4$, and $[Cu(NH_3)]SO_4$ using a NaI(Tl) crystal. Small variations were found for the decay rate of ^{64}Cu. (J.W.R.)

44863 OPTICAL-MODEL PARAMETERS FOR ELASTICALLY SCATTERED 30- AND 35-MeV ^{3}He IONS. Luetzelschwab, John William. St. Louis, Washington Univ., 1968. 144p.

Thesis.

Measured differential cross sections are reported for 30-MeV ^{3}He ions elastically scattered from ^{27}Al, ^{59}Co, ^{60}Ni, ^{89}Y, ^{90}Zr, ^{114}Cd, ^{115}In, and ^{116}Sn for angles between 6° and 165° and for 35-MeV ^{3}He ions elastically scattered from ^{59}Co, ^{60}Ni, ^{115}In, and ^{116}Sn for angles between 6° and 140°. The data are compared with predictions of the nuclear optical model and potential parameters that produce optimum fits with a least squares computer routine are reported. Good fits are back angles for ^{27}Al, ^{51}V, ^{59}Co, and ^{60}Ni are obtained only with the inclusion of a spin-orbit interaction with a magnitude of between 2 and 5 MeV for most cases. The back-angle data for these nuclei also tend to suppress discrete ambiguities in the potential well depths. A continuous ambiguity between the radius and the diffuseness parameters is found to be related to a constancy of the root-mean-square radius. Effects of experimental uncertainties on the potential parameters are presented. A detailed description of the laboratory equipment and experimental procedure used is contained in four appendices. The utilization of a 30° bending magnet for defining the cyclotron beam energy to within 1% is described. The experiments were performed in a 1.1 m diameter scattering chamber which is also described. Finally, fabrication of the target foils and the determination of their areal densities is discussed. (Diss. Abstr.)

44864 STUDIES ON THE γ-RAY TRANSITIONS OF ODD–ODD NUCLEI ^{90,92}Nb AND ^{58,60}Cu FROM THE (p,nγ) REACTIONS. Yoshida, Yoshiteru; Taketani, Hiroshi (Tokyo Inst. of Tech.). Genshikaku Kenkyu, 13: 631-63(May 1969). (In Japanese).

Gamma transitions in four odd-odd nuclei ^{90,92}Nb, ^{58,60}Cu were studied following ^{90,92}Zr, ^{58,60}Ni(p,nγ) reactions using 14- or 12.5-MeV protons. Singles γ spectra (Ge S.S.D., ≈ 8cc, planer type), neutron (plastic scintillation counter) gated gamma (Ge) spectra and γ (Ge)–γ (Ge) coincidence spectra were observed. In each gamma ray spectra, every peak was carefully identified with (p,nγ), (p,p'γ), γ rays following the other reactions or activated background γ rays using all nuclear level schemes and gamma-ray transitions now available and also n-γ and γ-γ coincidence studies. In ^{90}Nb, $J^\pi = 5^-$, the 362-keV excited states which has probably $[(P_{\frac{1}{2}})_p(G_{\frac{9}{2}})_n^{-1}]$ configuration was assigned by observing the 237-keV γ transition to $J^\pi = 4^-$ 125-keV excited state. Three of four M1 γ transitions between probably $[(G_{\frac{9}{2}})_p, (G_{\frac{9}{2}})_n^{-1}]$ $2^+ \rightarrow 3^+ \rightarrow 4^+ \rightarrow 5^+ \rightarrow 6^+$ levels were also observed and from the γ ray intensities the energy values of the levels were made somewhat reliable. In ^{92}Nb, gamma transitions between all eight energy levels of $[(G_{\frac{9}{2}})_p(d_{\frac{5}{2}})_n]$ $2^+ \sim 7^+$ and $[(P_{\frac{1}{2}})_p(d_{\frac{5}{2}})_n]$ 2^-, 3^- configurations were observed which are completely consistent with the spins and parities assigned by the ^{91}Zr(^{3}He,d) reaction. Strong enhancement in E1 transitions, weak or no hindrance in M1 transitions and weak or no enhancement in E2 transi-

tions were observed. In ^{58}Cu, about ten γ transitions were observed and the energy of every level was accurately determined and two new levels are proposed. In ^{60}Cu, twenty-five γ transitions were observed, six of them were already known, and any of them except one corresponds to every energy level which was observed by the ^{58}Ni(^{3}He,P) reaction. (auth) (NSA of Japan)

44865 ^{51}V(n,α)^{48}Sc MEAN REACTOR CROSS-SECTION. Batsleer, R.; Op de Beeck, J. P.; Hoste, J. (Ghent Univ.). Radiochem. Radioanal. Lett., 1: 311-17(Aug. 25, 1969).

The mean reactor cross-section for the reaction ^{51}V(n,α)^{48}Sc was determined by comparison with the reaction ^{27}Al(n,α)^{24}Na, the cross-section of which is well known. An average value of 16 ± 1 microbarn was found in agreement with some of the values cited in the literature. (auth)

44866 DECAY OF ^{83}Br–^{83m}Kr. Philippe, A.; Ballaux, C.; Dams, R.; Adams, F. (Ghent Univ.). Radiochem. Radioanal. Lett., 1: 351-63(Aug. 25, 1969).

The half-life of the isotope ^{83m}Se was found to be 70.4 ± 0.3 sec, and 2.35 ± 0.04 h for the isotope ^{83}Br. γ transitions at 118.9, 127.9, 520.7, 559.5, 552.5, 648.4, and 680.6 keV were detected in the decay of ^{83}Br. The energy determinations were performed by Ge(Li) spectrometry with a precision of at least 0.5 keV. The measurements were performed on ^{83}Br which was separated radiochemically. The energy of the transition of ^{83m}Kr at 9.35 ± 0.05 was determined precisely with a Si(Li) detector. A decay scheme for the decay of ^{83}Br is proposed. (auth)

44867 INTERNAL CONVERSION COEFFICIENTS IN ^{57}Fe, ^{119m}Sn, AND ^{195}Pt. Fink, Tobin. New Brunswick, N. J., Rutgers-The State Univ., 1968. 186p.

Thesis.

Measurements of the total and subshell internal conversion coefficients for the low level transitions in ^{57}Fe, ^{195}Pt and ^{119}Sm following electron capture in ^{57}Co and ^{195}Au and the decay of the isomer level in ^{119m}Sn are reported. The internal conversion spectra were measured with a magnetic solenoid spectrometer employing a two cycle baffle and a Geiger–Mueller counter for electron detection. The spectrometer was energy calibrated using the K internal conversion lines of the (569.62 ± 0.06) keV and (1063.44 ± 0.09) keV gamma-ray transitions in ^{207}Pb. The spectrometer transmission was determined from the measured intensity of the K internal conversion line of the 569-keV gamma-ray transition from a source calibrated with a gamma-ray Ge(Li) spectrometer. Analysis of Kurie plots for the continuous β^--spectrum of three ^{63}Ni sources of varying thickness mounted on backings of different thickness and atomic number, equivalent to the environment found for the three sources studied, indicated the corrections to be made for absorption of low energy electrons in the counter window, scattering in the source backing and scattering and absorption in the source itself. The resulting values of the internal conversion coefficients were compared to other measurements of these coefficients and to the theoretical calculations of Rose, Sliv and Band and Hager and Seltzer. (Diss. Abstr.)

44868 PARTICLE–HOLE STATES IN ^{48}Sc OBSERVED VIA THE ^{48}Ca(^{3}He,t) REACTION. Schwartz, J. J.; Watson, B. A. (Stanford Univ., Calif.). Phys. Lett., 29B: 567-9(Aug. 4, 1969).

A number of levels in ^{48}Sc are observed and identified with particle-hole configurations. Tentative spins are assigned to some states on the basis of their angular distributions. (auth)

44869 THE DECAY OF ^{73}As. Douglas, D. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 47: 1813-18(Sept. 1, 1969).

The relative intensities of the gamma and x rays of ^{73}As were measured with a Si(Li) spectrometer and the information used for the calculation of conversion coefficients. These are compared with theoretical values. Sufficiently precise gamma energy measurements were made to remove an ambiguity in the ordering of two close energy levels. (auth) (Canada)

44870 CORE POLARIZATION AND PARTICLE–HOLE EXCITATIONS IN ^{40}Ca AND ^{48}Ca. Blomqvist, J.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). Contract AT(30-1)-4032. Phys. Lett., 29B: 544-7(Aug. 4, 1969).

Using the Hamada–Johnston interaction, the negative parity particle-hole excitations of ^{40}Ca and ^{48}Ca are calculated with and without the inclusion of core polarizations. The lowest 3^- states are found to be very sensitive to core polarizations. The random-phase approximation with the bare matrix elements overestimates the collectivity of these 3^- states. The inclusion of the exchange self-screening diagram (A_{ph}) largely reduced the collectivity, and thus improves the agreement with experiment. The calculated energies of the low-lying states of ^{48}Ca are in significantly better agreement with experiment than for ^{40}Ca when the core-deformation components are not included in the wave functions for both nuclei. The experimental relative transition strengths of the 3^- and 5^- states in ^{40}Ca and ^{48}Ca are satisfactorily reproduced by the calculation. (auth)

44871 TWO-PARTICLE TWO-HOLE ADMIXTURES IN 2s–1d SHELL NUCLEI. Padjen, R.; Ripka, G. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett., 29B: 548-50(Aug. 4, 1969).

Two-particle two-hole admixtures to the Hartree–Fock states of ^{20}Ne, ^{28}Si and ^{32}S are calculated by exact diagonalization. The change of equilibrium deformation due to the admixtures is studied. (auth)

44872 HALF-LIFE MEASUREMENTS OF LEVELS IN ^{75}As. Hoejeberg, Mats (Univ. of Stockholm); Malmskog, Sven G. Nucl. Phys., A133: 691-7(1969).

Half-lives for several levels in ^{75}As have been determined using an electron–electron coincidence spectrometer. The following results have been obtained: $T_{\frac{1}{2}}$(199 keV) = 0.87 ± 0.03 nsec, $T_{\frac{1}{2}}$(280 keV) = 0.28 ± 0.02 nsec and $T_{\frac{1}{2}}$(401 keV) = 1.67 ± 0.14 nsec. (auth)

44873 GAMMA-GAMMA ANGULAR-CORRELATION MEASUREMENTS IN THE ^{44}Ca(n,γ)^{45}Ca REACTION. Gruppelaar, H. (Univ., Utrecht). Nucl. Phys., A133: 545-53(1969).

Angular correlation measurements of γ-radiation following thermal neutron capture in ^{44}Ca have been performed with a combination of Ge(Li) and NaI detectors. Spins could be assigned to the following ^{45}Ca levels (E_x in MeV): $J^\pi(0.17) = (\frac{5}{2},\frac{7}{2}^+)$, $J^\pi(1.44) = \frac{3}{2}^-$, $J^\pi(1.90) = \frac{5}{2}^-$ and $J^\pi(2.25) = \frac{1}{2}^-$ assignment is consistent with recent shell-model calculations. Some E2/M1 mixing ratios of transitions between bound states of ^{45}Ca have been determined. (auth)

44874 COULOMB DISPLACEMENT ENERGIES FOR Zn–Ga ISOBARS. Dzubay, T. G. (Princeton Univ., N. J.). Nucl. Phys., A133: 653-8(1969).

Fast neutrons from (p,n) reactions due to 18 MeV protons incident on zinc targets are detected by means of the ^{28}Si(n,α)^{25}Mg reaction taking place in the volume of a 2 mm deep surface barrier-detector. Energy resolution for 8 to 12 MeV neutrons was observed to be 160 keV. Despite the difficulties of a continuous neutron background and the fact that (n,α) reactions in silicon can leave the ^{25}Mg in many allowed excited states, it was possible to see isobaric analogs of the ground states of the zinc target nuclei in the gallium isotopes. By using the detector to measure the energy of neutrons corresponding to these states, Coulomb displacement energies for the Zn–Ga isobars are determined to be 9890, 9800, 9790, 9760, and 9620 ± 50 keV for A = 64, 66, 67, 68, and 70, respectively. These results are consistent with the $A^{-\frac{1}{3}}$ dependence which is characteristic of other nuclei in this mass region. (auth)

44875 STUDY OF PHOTOACTIVATION WITH A ^{60}Co SOURCE. Law, J.; Iddings, F. A. (Longwood Coll., Farmville, Va. Louisiana State Univ., Baton Rouge). J. Radioanal. Chem., 3: 53-63 (July 1969).

Photoactivation of 13 elements was studied using 5,000 Ci and 30,000 Ci sources. Reported data from the study are presented in tables including experimental conditions, observed activity, sensitivity achieved, gamma energies and half-life observed, and reaction cross-sections. Comparisons are made between this research and earlier reports. (auth)

44876 CAPTURE CROSS-SECTION MEASUREMENTS OF SOME MEDIUM- AND HEAVY-WEIGHT NUCLEI IN THE keV REGION. Kompe, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A133: 513-36(1969).

The radiative neutron capture cross sections of Nb, Mo, Pd, Ag, Cd, In, Cs, Hf, Ta, W and Re were measured relative to that of Au in the energy range from 10 to 150 keV by the time-of-flight method. A large liquid scintillator was used as detector. The capture cross section of Au was determined from measurements performed relative to the ^{10}B(n,α)^{7}Li* and ^{6}Li(n,α)^{3}H reactions and relative to a flat-response neutron monitor; these three measurements were normalized at 30 keV. The data were analyzed for p- and d-wave strength functions. (auth)

44877 DECAY OF ^{53}V AND ^{57}Mn. Ward, T. E.; Pile, P. H.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Nucl. Phys., A134: 60-7(1969).

The 1.287 MeV level ($J^\pi = \frac{7}{2}^-$) in ^{53}Cr was found to be populated in the β-decay of 1.60 min ^{53}V. Beta-gamma coincidences revealed β-rays of 2.50 and 2.20 MeV in coincidence with the 1.003 and 1.287 MeV levels in ^{53}Cr. Four new γ-rays were found in the decay of 1.54 min ^{57}Mn. The energy level of 1.625 MeV in ^{57}Fe was found to be populated. Beta decay of ^{57}Mn ($J^\pi = \frac{5}{2}^-$) to the

0.014 MeV level ($J^\pi = \frac{3}{2}^-$) in ^{57}Fe was measured to be 83.5%. The beta decay Q-value of ^{57}Mn was determined to be 2.56 ± 0.10 MeV. (auth)

44878 DETERMINATION OF THE SPIN AND THE RESONANCE PARAMETERS FOR Cl + n, Cu + n, Ba + n, AND Nd + n. Alves, R. N.; De Barros, S.; Chevillon, P. L.; Julien, J.; Morgenstern, J.; Samour, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A134: 118-40(1969). (In French).

Experiments on some nuclei have been performed with the Saclay linear accelerator using the time-of-flight method. The investigated energy range is 9–113 keV for Cl, 200–31,000 eV for Cu, 20–1000 eV for Ba and 3–370 eV for Nd. The spin value is assigned to most of the resonances. Strength function values against the spin value and the mass number A are discussed. (auth)

44879 THE ^{40}Ca(d,n)^{41}Sc REACTION: NEUTRON POLARIZATION AND ANGULAR DISTRIBUTION MEASUREMENTS. Gedcke, D. A.; Lam, S. T.; Tang, S. M.; Stinson, G. M.; Sample, J. T.; Grandy, T. B.; McDonald, W. J.; Dawson, W. K.; Neilson, G. C. (Univ. of Alberta, Edmonton). Nucl. Phys., A134: 141-60(1969).

The angular distributions and neutron polarizations have been measured for the reaction ^{40}Ca(d,n)^{41}Sc at a deuteron bombarding energy of 6 MeV. The polarization measurements, from 0 to 120°, were made for neutron groups corresponding to the ground, 1.718 MeV and 2.415 MeV states in ^{41}Sc. Additional angular distribution measurements were made for neutron groups corresponding to the 2.096, 2.719, and 3.463 MeV states in ^{41}Sc. Good agreement is found between the observed and DWBA predicted neutron angular distributions. No satisfactory agreement between the experimental and calculated neutron polarizations is found for any reasonable choice of optical parameters. (auth)

44880 PROTON SEPARATION ENERGIES DERIVED FROM THE (d,^{3}He) REACTION ON f-p SHELL NUCLEI AT 52 MeV. Mairle, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Kaschl, G. Th.; Link, H.; Mackh, H.; Schmidt-Rohr, U.; Wagner, G. J.; Turek, P. Nucl. Phys., A134: 180-98(1969).

The (d,^{3}He) reaction was investigated by 52 MeV deuterons on ^{45}Sc, ^{54}Fe, ^{58}Ni, ^{60}Ni, ^{63}Cu, and ^{65}Cu. The measured angular distributions were compared with local zero-range DWBA calculations from which the angular momenta of the transferred protons and the spectroscopic factors were deduced. The centers of gravity of the binding energies were determined for the $1f_{\frac{7}{2}}$, $1d_{\frac{3}{2}}$, and $2s_{\frac{1}{2}}$ proton hole states. Taking into consideration the results of proton pick-up experiments on ten other f-p shell nuclei partly investigated by us previously, it was possible to study the systematic behavior of the binding energies. In the lower f-p shell for nuclei with A ≦ 48, the $2s_{\frac{1}{2}}$ protons are in the average more tightly bound than the $1d_{\frac{3}{2}}$ protons, and the reverse is true for A > 48. A Bansal and French type calculation based on an average particle-hole interaction $E_{ph} = -\bar{E} + \Delta\bar{E}\,(t_p \cdot t_h)$ proved to reproduce the observed data. The parameters $\bar{E}$ and $\Delta\bar{E}$ have been determined for the $1d_{\frac{3}{2}} - f_{\frac{7}{2}}$ and the $2s_{\frac{1}{2}} - f_{\frac{7}{2}}$ interaction by means of a least-squares fit procedure considering the experimental binding energies in altogether 16 nuclei. (auth)

44881 FLUCTUATIONS IN THE NEUTRON CROSS SECTIONS OF SILICON. Grimes, Steven Munroe. Madison, Wis., Univ. of Wisconsin, 1968. 132p.

Thesis.

The total neutron cross section, the 15 and 30° neutron elastic scattering cross sections, and the $\sigma(n,\alpha_0)$, $\sigma(n,\alpha_1)$, $\sigma(n,\alpha_2)$, $\sigma(n,\alpha_3)$, $\sigma(n,p_{3+1})$ and $\sigma(n,p_{2+3})$ cross sections of Si were measured with an energy spread of 30 keV in 30-keV steps between 6.7 and 13.4 MeV. The neutron beam was obtained by bombarding a tritium gas target with protons for low neutron energies and a deuterium gas target with deuterons for the high neutron energies. Liquid hydrogenous scintillators viewed by phototubes were used as neutron detectors for the $\sigma(15°)$, $\sigma(30°)$ and σ_T data. A silicon surface barrier detector served as both target and detector in the charged particle measurements. Fluctuations whose size decreased with energy appeared in each cross section. The widths and magnitudes observed were compared with predictions of Ericson theory. Level densities were obtained which were in reasonable agreement with theory. Comparison of the average level spacing with measured correlation widths indicated that the conditions for validity of Ericson theory were satisfied. The average (n,p) and (n,α) cross sections were compared with values calculated from Hauser–Feshbach theory. In no case was the experimental value inconsistent with the calculated one, although both the experimental and theoretical values were subject to substantial uncertainties. A search for cross correlations between different cross sections was conducted. The results of this analysis were again in agreement with Ericson theory and were not consistent with the values expected if intermediate structure were present. The results of the fluctuation analysis as well as the Hauser–Feshbach calculation indicated that the contribution to the (n,p) and (n,α) cross sections from direct processes was small. A similar analysis for the elastic sections gave the fraction of the elastic scattering cross section at 15 and 30° caused by shape elastic scattering. (Disser. Abstr.)

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Refer also to abstracts 43568, 43577, 44571, 44678, 44825, 44830, 44848, 44849, 44853, 44854, 44859, 44863, 44864, 44867, 44875, 44876, 44878, 44951, 44964, 44993, and 44994.

44882 (COO-1746-24) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 2, June 1, 1968–May 31, 1969. Steffen, R. M. (Purdue Univ., Lafayette, Ind. Nuclear Structure Lab.). June 15, 1969. Contract AT(11-1)-1746. 52p. Dep. CFSTI.

CADMIUM-110 — energy-level transitions from silver-110 decay, multipole mining ratios for, (E)
CADMIUM-114 — energy level of, lifetime of first excited, (E)
GERMANIUM-74 — energy level at 596 keV, static quadrupole moment for, (E)
GERMANIUM-76 — energy level at 563 keV, static quadrupole moment for, (E)
GOLD-197 — energy-level transitions in, angular correlation coefficients for
NICKEL-60 — energy level of, lifetime of first excited, (E)
PLATINUM-192 — energy level at 612 keV, g-factor for, (E)
— energy levels of, lifetimes for, (E)
PLATINUM-195 — energy-level transitions in, angular correlation coefficients for
SILVER-110 — beta decay of isomeric, γ spectra for, (E)
TIN-117 — isomeric transition in, angular correlation coefficient for
TITANIUM-46 — energy level of, lifetime of first excited, (E)
TUNGSTEN-184 — energy-level transition in, conversion-electron particle parameters for 111-keV, (E)
VAN de GRAAFF ACCELERATORS — installation of FN-tandem, at Purdue University
— experimental facilities at Purdue FN-tandem (J.W.R.)

44883 (INR-1033) CORRELATED EMISSION OF LIGHT NUCLEI AND NEUTRONS IN FISSION OF ^{235}U. Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Piekarz, H.; Tys, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 7p. Dep. CFSTI (U. S. Sales Only).

The yields of protons and tritons in relation to the α-particle yield were measured in coincidence with the prompt fission neutrons from thermal neutron fission of ^{235}U. A conclusion as to the relation between the average number of prompt neutrons and the type of charged particles involved was deduced by making assumptions as to the angular and energy distributions of the neutrons. (auth)

44884 (JINR-P6-4494) A SHORT-LIVED ISOMER IN ^{203}At. Morek, T.; Noibert, V.; Khoinatskii, S.; Aleksander, K.; Vil'gel'mi, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 11p. (In Russian). Dep.

In the reactions ^{197}Au(^{12}C,6n)^{203}At and ^{191}Ir(^{18}O,6n)^{203}At an isomeric level with a half-life of 108 ± 10 msec was found. The multipolarity of the 585-keV transition to the ground state is E3. Furthermore gamma rays with energies 426, 682, and 516 keV following the β decay of ^{204}At ($T_{\frac{1}{2}}$ = 10 ± 1 min) were observed. Possible interpretations for the isomerism in ^{203}At are discussed. (auth)

44885 (JINR-P6-4499) AN ISOMERIC TRANSITION IN ^{135}Ce. Vil'gel'mi, Z.; Droste, Kh.; Levitovich, E.; Morek, T.; Khoinatskii, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 11p. (In Russian). Dep.

The conversion electron spectrum from the decay of an isomeric level of ^{135}Ce, produced in the reaction ^{129}Te(^{12}C,5n)^{135}Ce, was investigated. In the decay of ^{135m}Ce transitions with 82, 150, 213, and 150 keV energies were observed. For the isomeric transition with energy of 150 keV the α_K/α_L ratio was obtained. It suggests E3 multipolarity for this transition. (auth)

44886 (KFK-tr-294) INFLUENCE OF THE HEXADECAPOLE DEFORMATION ON THE PROPERTIES OF QUASI- PARTICLE STATES OF NUCLEI IN THE REGION OF THE RARE EARTHS. Gareev, F. A.; Ivanova, S. P.; Shirikova, N. Yu. (Joint Inst. for

Nuclear Research, Dubna (USSR)). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, W. Ger.), from report JINR-P4-4259. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 19251.

44887 (N-69-24826) ANALYSIS OF GOLD SPHERE TRANSMISSION EXPERIMENTS AT 24-keV NEUTRON ENERGY USING SPIN-DEPENDENT s-WAVE STATISTICS. Semler, Thor T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1969. 23p. (NASA-TN-D-5211). CFSTI.

The average capture cross section for gold at a neutron energy of 24 keV was obtained by analysis of published sphere transmission experiments that use Sb-Be source neutrons. The analysis compares results using merged s-wave spin-state statistical data and separated spin-state statistical data. Values of 725 ± 30 mb are obtained using separated spin-state data, and 660 ± 30 mb using merged spin-state data. The value of 725 ± 30 mb is in agreement with the larger of recent gold activation cross section measurements at 24 keV, which have a range of from 640 ± 35 mb to 713 ± 40 mb for the average capture cross section. (auth)

44888 (PPAR-15) LEVELS IN ^{203}Bi, ^{205}Bi, AND ^{207}Bi. Hopke, P. K.; Naumann, R. A.; Spejewski, E. H. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). July 10, 1969. Contract AT(30-1)-2137. 42p. Dep. CFSTI.

The decay of the odd-mass isotopes of polonium to levels in ^{203}Bi, ^{205}Bi, and ^{207}Bi were studied. Isotopically separated sources were produced in the Princeton-Pennsylvania Accelerator and mass dispersed by means of the Princeton electromagnetic isotope separator. Gamma ray and conversion electron spectra were observed. With the aid of gamma-gamma coincidences, level schemes were constructed for these three bismuth isotopes. (auth)

44889 (RLO-1759-20) FISSION STUDIES ON ELEMENTS BELOW POLONIUM. Progress Report, August 1, 1968-July 1, 1969. Neuzil, Edward F. (Western Washington State Coll., Bellingham). Contract AT(45-1)-1759. 11p. Dep. CFSTI.

Studies on the alpha fission of ^{204}Pb and ^{208}Pb at 25 to 65 MeV are described. (J.W.R.)

44890 (UCRL-71827) PHOTONEUTRON CROSS SECTIONS FOR ^{138}Ba AND ^{14}N. Berman, B. L.; Fultz, S. C.; Caldwell, J. T.; Kelly, M. A. (California Univ., Livermore. Lawrence Radiation Lab.). June 27, 1969. 7p. (CONF-690816-1). Dep. CFSTI.

From Gordon Conference for Photonuclear Reactions, Tilton, N. H.

Photoneutron cross sections, including $\sigma[(\gamma,n) + (\gamma,pn)]$, $\sigma(\gamma,2n)$, and $\sigma(\gamma,3n)$ for ^{138}Ba and $\alpha[(\gamma,n) + (\gamma,pn)]$ for ^{14}N, were measured as a function of photon energy from threshold to 30 MeV. (B.G.D.)

44891 DETERMINATION OF THE CHARGE OF A HEAVY NUCLEUS. Semikoz, V. B. JETP Lett. (USSR) (Engl. Transl.), 9: 324-6(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 534-7(May 5, 1969).

A refinement of the theoretical formulas used to determine the charges of relativistic heavy nuclei is presented. (J.W.R.)

44892 FISSION OF ^{238}Pu BY s AND p NEUTRONS. Ermagambetov, S. B.; Smirenkin, G. N. JETP Lett. (USSR) (Engl. Transl.), 9: 309-10(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 510-13(May 5, 1969).

The cross section for neutron fission of ^{238}Pu at E_n = 1 to 1000 keV was measured. The cross section was compared with optical model calculations for s- and p-wave neutrons. It was concluded that the average fission widths for s- and p-wave neutrons are comparable. (J.W.R.)

44893 TOTAL ABSORPTION METHOD FOR INVESTIGATION OF THE K-CAPTURE PROBABILITY OF ^{139}Ce. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary); Hohmuth, K. pp 88-91 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

A CsI(Tl) spectrometer for total absorption of x rays and auger electrons is described. The k-capture probability of ^{139}Ce was determined using the total absorption method. (J.W.R.)

44894 THE ORBITAL ELECTRON-CAPTURE IN ^{109}Cd. Goedbloed, W. (Univ., Amsterdam). pp 92-6 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The capture decay of ^{109}Cd-^{109}Ag was investigated by means of a 4π scintillation spectrometer. The spectrometer consisted of two truncated cones of NaI(Tl) sandwiching a small source crystal. This source crystal is a NaI(Tl) crystal, grown from the melt, containing a ^{109}Cd source. The orbital electron-capture probability ratios obtained by direct measurements are $P_{LM..}/P_K = 0.226 \pm 0.003$ and $P_L/P_K = 0.193 \pm 0.003$. The ratio $P_{MN..}/P_L = 0.171 \pm 0.035$ deduced from these values is in disagreement with the theoretical result (0.231) extrapolated from values of Bahcall. (auth)

44895 THE P_{L_I}/P_K CAPTURE IN ^{133}Ba. Narang, V.; Houtermans, H. (International Atomic Energy Agency, Vienna). pp 97-101 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1. Berenyi, D.(ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The K-capture probability and the L/K ratio for ^{133}Ba were measured using the X-γ coincidence method. The efficiency of the x-ray counter was determined using a ^{137}Cs source. (J.W.R.)

44896 THE LEVELS IN ^{159}Tb POPULATED FROM THE β^- DECAY OF ^{159}Gd AND ELECTRON CAPTURE DECAY OF ^{159}Dy. Mysiek, B.; Sujkowski, Z.; Kotlinska, B. (Inst. of Nuclear Research, Swierk, Poland). pp 102-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 1 Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The γ spectra from the beta decay of ^{159}Gd and the electron-capture decay of ^{159}Dy were investigated with Ge(Li) detectors. The Q-values for the decays were measured and the γ branching ratios for several transitions in ^{159}Tb were determined. (J.W.R.)

44897 ELECTRON CAPTURE DECAY OF ^{207}Bi: L SUBSHELL FLUORESCENCE YIELDS AND COSTER-KRONIG TRANSITION PROBABILITIES IN Pb. Rao, P. Venugopala; Wood, R. E.; Palms, J. M. (Emory Univ., Atlanta). pp 264-8 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

A fast coincidence system was used to measure the x rays produced during the decay of ^{207}Bi by electron capture and internal conversion. The L subshell fluorescence yields and Coster-Kronig transition probabilities in Pb were determined. (J.W.R.)

44898 DIFFERENTIAL INTERNAL BREMSSTRAHLUNG SPECTRUM FROM THE NON-UNIQUE FIRST FORBIDDEN BETA DECAY OF ^{143}Pr. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary); Vatai, E.; Scharbert, T.; Bruecher, E. pp 192-5 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The internal bremsstrahlung accompanying the non-unique first forbidden β decay of ^{143}Pr was studied in a β-γ coincidence arrangement at 90°. A positive deviation from the KUB and Coulomb-corrected KUB theoretical spectrum distributions was found. (J.W.R.)

44899 DIFFERENTIAL INTEGRAL BREMSSTRAHLUNG SPECTRUM FROM THE UNIQUE FIRST FORBIDDEN BETA DECAY OF ^{204}Tl. Scharbert, T.; Berenyi, D.; Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). pp 196-200 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The differential internal bremstrahlung spectrum from the β decay of ^{204}Tl was examined at 90° in an arrangement with the beta and gamma detectors were surrounded by a lead shield with a conical opening toward the source. There was a definite disagreement between experiment and theory up to 400 keV. (J.W.R.)

44900 INTERNAL BREMSSTRAHLUNG ACCOMPANYING THE ELECTRON-CAPTURE DECAY OF ^{145}Sm. Sujkowski, Z.;

Mysiek, B.; Zglinski, A.; Adamowicz, B. (Inst. for Nuclear Research, Swierk, Poland). pp 163-8 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The singles internal bremsstrahlung spectrum from the electron-capture decay of ^{145}Sn was observed using scintillation detectors with fast electronics. The internal bremstrahlung was also observed in coincidence with the k x rays and the 61-keV internal conversion electrons. The spectra were compared with calculations and the differences were small enough to be explained by systematic experimental errors. (J.W.R)

44901 THE NATURE OF LOW-LYING EXCITED STATES OF ^{151}Pm. Voinova, N. A.; Egorov, A. I.; Kalinichev, Yu. V.; Sergeev, A. G. (Ioffe Inst. of Physics and Tech., Leningrad). pp 458-64 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The internal conversion coefficients for energy level transitions in ^{151}Pm following ^{151}Nd decay were determined. The γ and conversion electron spectra were measured simultaneously using a Ge(Li)–Si(Li) system. Multipolarities for a number of transitions were determined. The data show that the low-lying portion of the ^{151}Pm level scheme consists of three rotational bands as expected from the Nilsson single-particle model. (J.W.R.)

44902 DECAY OF ^{155}Tb TO LEVELS IN ^{155}Gd. Meyer, R. A.; Gunnink, R. (Univ. of California, Livermore). pp 465-73 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The electron capture decay of ^{155}Tb was studied by gamma ray spectroscopy. By using a Compton suppression spectrometer and a high resolution Ge(Li) detector (full width at half maximum of 530 eV for a 60-keV gamma ray) approximately 80 gamma rays were detected in the decay of isotopically separated ^{155}Tb. The energies of the more intense peaks were measured to a precision of 40 eV. The energy of the gamma rays below 350 keV are found to be in agreement with the corrected conversion electron data of Kormicki et al. (auth)

44903 PROPERTIES OF STATES EXCITED IN ^{181}Re AND ^{182}Re FOLLOWING ORBITAL ELECTRON CAPTURE IN ^{181}Os (105 m) AND ^{182}Os (22 h). Burson, S. B. (Argonne National Lab., Ill.). pp 475-9 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

Sources of ^{181}Os and ^{182}Os were produced by irradiating enriched ^{182}W with 35-MeV ^{3}He particles. The conversion electron spectra were investigated with a Si(Li) detector provided with a superconducting magnet which serves as a condensing lens. A large number of transitions in ^{181}Re and ^{182}Re were observed. Internal conversion coefficients, multipolarities, and spin-parity assignments are presented. (J.W.R.)

44904 THE NEW DATA ON THE CIRCULAR POLARIZATION OF THE ^{181}Ta γ QUANTA. Lobashov, V. M.; Nazarenko, V. A.; Saenko, L. F.; Smotritskii, L. M.; Kharkevitsch, G. I. (Ioffe Inst. of Physics and Tech., Leningrad). pp 480-7 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The circular polarization of the 482-keV γ-transition in ^{181}Ta occurring in the decay of ^{181}Hf was measured. Corrections were made for the internal bremsstrahlung effect in the β-decay and for the magnetostriction effect. (J.W.R.)

44905 INTERNAL CONVERSION RATIOS FOR THE HIGHER SHELLS AT THE 364-keV TRANSITION IN THE DECAY OF ^{131}I. Juhasz, S.; Ujhelyi, Cs.; Berenyi, D.; Illes, F. (Inst. of Nuclear Research, Debrecen, Hungary). pp 438-41 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The L/M and M/(N + O) ratios for 364-keV transition in ^{131}Xe were determined using a magnetic β spectrometer. (J.W.R.)

44906 PROPERTIES OF THE β- AND γ-VIBRATIONAL BANDS IN ^{152}Sm AND ^{154}Gd. Johnson, Noah R. (Oak Ridge National Lab., Tenn.); Riedinger, L. L.; Hamilton, J. H. pp 443-3b of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The failure of the perturbation treatment of the non-adiabatic effects in band mixing in ^{152}Sm and ^{154}Gd is discussed. Some band-mixing parameters for ^{152}Sm and ^{154}Gd are presented. (J.W.R.)

44907 NUCLEAR RESONANCE FLUORESCENCE AFTER ELECTRON CAPTURE. Langhoff, H. (Physikalisches Institut, Goettingen, Ger.). pp 418-22 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The use of nuclear resonance fluorescence in gases to determine electron-capture properties of the constituent nuclei is discussed. The transition energy for electron-capture decay in ^{127}Xe was determined by studying the resonant excitation of the 375-keV level in the ^{127}I daughter. The transition energy for electron-capture in ^{69}Ge was also determined using gaseous molecular sources. (J.W.R.)

44908 INTERNAL CONVERSION STUDY OF DOUBLE DECAY PROCESSES. Vukanovic, R.; Samuelsson, L.; Migahed, M.; Westerberg, L. (Uppsala Univ.). pp 391-4 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The presence of double decay events in the 192-keV E4 transition in the decay of ^{144m}In was investigated. Coincidence events with energy relations in agreement with K–K, K–L, L–L, and γ–K double decays were detected using three magnetic beta spectrometers and a NaI (Tl) gamma detector. (J.W.R.)

44909 SEARCH FOR DOUBLE QUANTUM EMISSION IN THE DECAY OF ^{131m}Xe. Fischbeck, H. J.; Abdulla, A. A. (Univ. of Oklahoma, Norman). pp 395-400 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

Double decay events were searched for in the radiation following the isomeric transition in ^{131}Xe. A Ge(Li) detector and a multichannel analyzer gated on the x-ray region were used. X ray-x ray coincidences corresponding to double photon decay were observed. (J.W.R.)

44910 INTERNAL COMPTON EFFECT. Ljubicic, A.; Hrastnik, B.; Ilakovac, K.; Knapp, V.; Vojnovic, B. (Inst. Ruder Boskovic, Zagreb). pp 401-5 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The energy distribution of γ rays from transitions involving the internal Compton effect (I.C.E.) in ^{137}Ba was studied. Identification of the I.C.E. events was made by two-dimensional energy analysis. The transition probabilities for the I.C.E. per unit γ-ray energy interval were obtained. (J.W.R.)

44911 THE BETA SPECTRUM INVESTIGATIONS IN DECAYS OF ^{134}Cs, ^{122}Sb AND ^{32}P. Kim, Moo Ung. Bloomington, Ind., Indiana Univ., 1968. 79p.

Thesis.

The beta-spectrum measurements of ^{134}Cs, ^{122}Sb and ^{32}P were performed with a high-resolution, 40 cm, 180-degree focusing, shaped magnetic-field spectrometer, employing the energy signature technique which discriminates against the background events and the scattered electrons. A lithium-drifted silicon detector with a depletion depth of 5 mm and a thin (<0.12 mg cm^2) entrance window was used as the detector. The intensities of the two outer $4^+ \rightarrow 2^+$ beta transitions in 0.045 ± 0.015% and 0.008 ± 0.004% were determined. After subtracting the two outer beta groups on the basis of an allowed shape, it was found that the shape of the 658-keV beta transition with an unusually large log ft value of 8.8 is essentially statistical. The end-point energy of

658.0 ± 0.4 keV for this $4^+ \text{---} 4^+$ beta transition was precisely determined by the energy signature technique which eliminates the "scattering tail" beyond the end-point energy in the usual Fermi-Kurie plot. There are two more inner beta transitions one of which has an end-point energy of 415 keV and an essentially statistical shape. This shape is consistent with a spin and parity assignment of 3^+ for a 1643-keV level in ^{134}Ba. The shape of the 1414 ± 3 keV beta transition from the 2^- ground state to a 2^+ (564 keV) level in ^{122}Te was found to be an essentially statistical one that most once-forbidden nonunique transitions exhibit. The shape of this beta transition was analyzed after the outermost beta group of a $2^- \text{---} 0^+$ transition had been subtracted on the basis of a correction factor $C(W) = L_0q^2 + 9L_1$. Thus, the number of solutions proposed by Pipkin et al., Phys. Rev. 129(1962) 2626, for the six nuclear matrix elements that enter into this $2^- \text{---} 2^+$ beta transition were reduced. A detailed investigation of the shape of a pure Gamow-Teller transition from the 1^+ ground state to the 0^+ ground state of ^{32}S was made. The end-point energy of 1709.5 ± 1.5 keV was obtained by a least-squares fit to the data above 1480 keV in the Fermi-Kurie plot. The experimental shape factor which has a small deviation from an allowed one was fitted with an empirical correction factor of the form $C(W) = 1 + aW + bW$ where $a = -0.007 \pm 0.005$ and $b = 0.154 \pm 0.034$. An equally good fit was obtained with $C(W) = 1 + bW$ where $b = 0.20 \pm 0.01$. The large log ft value of 7.9 for this allowed transition can be understood on the basis of L-forbidden ($\pi s_{1/2}, \nu d_{3/2}$) and/or cancellation effect. An attempt was also made to fit the nonstatistical shape with a theoretical correction factor of Moritas, Phys. Rev. 113(1959) 1584, treating the ratios of nuclear matrix elements as unknown parameters. Thus, the small deviation is explained by the interference terms of the second-forbidden matrix elements with the allowed one. (Disser. Abstr.)

44912 ELASTIC AND INELASTIC SCATTERING OF COMPLEX PARTICLES FROM VIBRATIONAL NUCLEI. Savin, William. New Brunswick, N. J., Rutgers–The State Univ., 1968. 146p.

Thesis.

Elastic and inelastic differential cross sections were measured for 16-MeV deuterons scattered from ^{112,116,118,120,122,124}Sn, ^{110,112,114,116}Cd, and ^{126,128,130}Te. Differential cross sections were also measured for 24-MeV elastically and inelastically scattered ^{3}He from ^{112,116,122,124}Sn. The states investigated were the 0^+ ground state and the strongly excited "one-phonon" quadrupole and octupole states. Optical model calculations were made for the deuteron elastic scattering by allowing all real and imaginary parameters to vary simultaneously. Discrete ambiguities in these parameters are discussed in light of recent calculations. Good fits to the experimental data were obtained. The optical model fits to ^{3}He elastic scattering data were made allowing only the real and imaginary radius to vary and good fits were obtained. Distorted wave Born approximation calculations, assuming the collective vibrational model, were made for the 2^+ and 3^- states. The "best fit" optical model parameters found for the different isotopes were used in these calculations. Calculated 2^+ cross sections for cadmium are seen to have their minima occur at larger scattering angles than the experimental data. This effect occurs in tellurium, but not as strongly as in cadmium, and is not seen in the tin isotopes. The calculations were made using a complex "collective" form factor and including Coulomb excitation. The effect of a real form factor is also discussed. Deformation parameters for all the 2^+ and 3^- states were extracted. Comparisons of the β_2's and β_3's found from the deuteron and ^{3}He scattering were made with results of proton, alpha particle, and Coulomb excitation. Serious discrepancies were found for the ^{3}He results when compared with the proton and Coulomb excitation results. The deuteron results show serious discrepancies with Coulomb excitation measurements for the cadmium 2^+ states. The deuteron β_2's and β_3's disagree with some of the proton and Coulomb excitation results in tin and tellurium. Comparisons of calculated B(E2)'s and B(E3)'s for tin and B(E2)'s for cadmium and tellurium with the deuteron and ^{3}He results show agreement with particular calculations, but because of the wide variation in calculated values, no general conclusions can be drawn. The most serious disagreement is for the tin isotopes where the calculated B(E3)'s increase with atomic weight while both the deuteron and ^{3}He show a decrease. (Disser. Abstr.)

44913 REORIENTATION EFFECT IN CADMIUM AND TIN ISOTOPES. Kleinfeld, Alan Marc. New Brunswick, N. J., Rutgers–The State Univ., 1968. 133p.

Thesis.

Coulomb excitation was used to determine the static quadrupole moment of the first 2^+ state and the reduced electric quadrupole transition probabilities from the ground to the first 2^+ state ($B(E2, 0^+ \rightarrow 2^+)$) of ^{106}Cd, ^{114}Cd, ^{116}Sn, and ^{124}Sn. The Coulomb excitation interpretation of these experiments was examined by performing the measurement for three different projectiles (α, ^{16}O, and ^{32}S), and observing the mass dependence of the reorientation effect. It is concluded that Coulomb excitation is a reliable tool with which the static quadrupole moment can be determined. The results are compared to the predictions of existing nuclear models. In their present state the models are found to be lacking in consistency as regards the experimental evidence for these nuclei. (Disser. Abstr.)

44914 AN INVESTIGATION OF SOME SECOND-ORDER ELECTROMAGNETIC NUCLEAR DECAY PROCESSES. Seykora, Edward Joseph. Raleigh, N. C., North Carolina State Univ., 1968. 71p.

Thesis.

Some second-order nuclear decay processes were studied using two NaI detectors to investigate the gamma-ray spectra which were in coincidence with the K x-rays following the decay of ^{203}Hg and ^{137}Cs. Such gamma-ray spectra represent a composite distribution from both internal Compton scattering and two-quantum (γe) decay. The resultant gamma-ray spectra were found to be in good agreement with the semiclassical distributions predicted for internal Compton scattering. Double internal conversion, a second-order electromagnetic decay process, has been previously investigated in several laboratories. The second purpose of this experiment was to determine whether or not the K-electrons are both internally converted in a time interval short compared with the mean life of the K-shell vacancy. The mean life of the K-shell vacancy is believed to be in the range of 10^{-17} to 10^{-16} sec. In such a situation (double ionization of the K-shell), the energy of the first x-ray (unshielded K-shell) would be approximately proportional to Z^2 and the second to $(Z-1)^2$. The coincident x-rays during the decay of ^{137}Cs and ^{203}Hg were investigated using a Ge(Li) detector and a thin NaI scintillation detector. Single-channel analyzers were used for energy selection (in the leading edge mode) for both detectors. The x-ray peak was bracketed in the case of the NaI detector, and the coincidence spectrum from the Ge(Li) detector with energies up to twice the K energy was recorded by means of a multi-channel analyzer. A net x-ray coincidence was observed in ^{203}Hg and to a larger extent in ^{137}Cs; however, the spectra did not yield x-rays proportional to Z^2 or any asymmetry toward the high energy side of the $K\alpha_1$ spectrum. The competing processes, electron shake-off and internal Compton scattering followed by internal conversion were considered theoretically. Theoretical order of magnitude estimates were made for the competing transition probabilities. (Disser. Abstr.)

44915 DETERMINATION OF THE LIFETIME OF SEVERAL EXCITED STATES OF ^{155}Eu AND ^{155}Gd. Sadekov, Kh. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 76-7(1969). (In Russian).

Excited states of ^{155}Eu and ^{155}Gd were formed by decay of ^{155}Sm which was formed by irradiation of enriched ^{154}Sm in a neutron reactor. By beta-gamma and gamma-gamma coincidence counting it was possible to find a lifetime of $1.26 \pm 0.03 \times 10^{-9}$ sec for the 246 keV level in ^{155}Eu. The lifetime of the 104.4 keV level in ^{155}Eu was below the sensitivity of the counter ($< 0.17 \times 10^{-9}$ sec). The lifetime of the 86.5 keV level in ^{155}Gd was found to be $T_{1/2} = 5.78 \pm 0.09 \times 10^{-9}$ sec. The lifetime of the 105.3 level in ^{155}Gd was resolved by counting on NaI and stilbene crystals, and was found to be $T_{1/2} = 1.21 \pm 0.05 \times 10^{-9}$ sec. Other levels of ^{155}Gd whose lifetimes would be within the limits of sensitivity of the equipment were not found. ^{155}Eu and ^{155}Gd belong to deformed nuclei. All the levels of ^{155}Eu and ^{155}Gd whose lifetimes are presented here belong to single particle states which are in good agreement with those predicted by Nilsson and in poor agreement with those predicted by Weiskopf. (TTT)

44916 NUCLEAR DATA SHEETS FOR A = 243 TO A = 261. Ellis, Y. A. (Oak Ridge National Lab., Tenn.); Wapstra, A. H. Nucl. Data, Sect. B, 3: B.3.2.1-B.3.2.132 (May 1969).

Level schemes and decay characteristics are presented for all nuclei with mass numbers between A = 243 and A = 261. Experimental data, adopted values, comparisons with theory, and arguments for spin and parity assignments are given. Emphasis is placed on the presentation of level schemes which seem "best" in the light of the data and theoretical ideas available at this time. Inconsistencies and discrepancies in the level schemes are discussed. (auth)

44917 BETA DECAY ANISOTROPY AND NUCLEAR MAGNETIC RESONANCE OF 14 s ^{116}In PRODUCED BY CAPTURE OF POLARIZED NEUTRONS. Ackermann, H. (Univ., Heidelberg); Dubbers, D.; Mertens, J.; Winnacker, A.; von Blanckenhagen, P. Phys. Lett., 29B: 485-6(July 21, 1969).

Polarized ^{116}In nuclei were produced by capture of polarized thermal neutrons. The nuclear polarization was monitored by measuring the β anisotropy of the decay of the ^{116}In ground state.

Nuclear magnetic resonance was observed in polycrystalline InP, InAs, and InSb with the result for the magnetic moment $\mu_I(^{116}In)$ = 2.7723(10) nm (uncorrected). (auth)

44918 COULOMB EXCITATION OF ^{127}I. Ward, D.; Geiger, J. S.; Graham, R. L. (Chalk River Nuclear Lab., Ont.). Phys. Lett., 29B: 487-8(July 21, 1969).

The Coulomb excitation of ^{127}I was studied with ^{16}O projectiles in the range 35 to 55 MeV. Three new levels were found, and spin assignments are made for some previously known levels. The results are compared with a recent intermediate coupling calculation. (auth)

44919 TIME DEPENDENCE OF COULOMB DISTORTIONS IN HEAVY-ION REACTIONS. Holm, H.; Scheid, W.; Greiner, W. (Univ., Frankfurt am Main. Univ. of Virginia, Charlottesville). Phys. Lett., 29B: 473-7(July 21, 1969).

The excitation of collective modes in heavy-ion scattering was calculated in a dynamic classical model and the deformation and polarization of the projectile and the target nucleus at the Coulomb barrier as a result of their mutual electrostatic forces were obtained. Examples are given for ^{148}Nd and ^{122}Sn. It is also shown that in special cases the Coulomb barrier can be lowered for deformed nuclei. (auth)

44920 REALISTIC INTERACTIONS AND EXCHANGE EFFECTS IN THE INELASTIC SCATTERING OF PROTONS. Love, W. G. (Oak Ridge National Lab., Tenn.); Owen, L. W.; Drisko, R. M.; Satchler, G. R.; Stafford, R.; Philpott, R. J.; Pinkston, W. T. Phys. Lett., 29B: 478-81(July 21, 1969).

The long-range part of the Hamada–Johnston potential was used as an effective interaction in a microscopic description of the inelastic scattering of protons. Knock-on exchange amplitudes are found to be smaller than when earlier phenomenological interactions were used, but are still very important. The contributions from interaction with the valence nucleons in nuclei with simple configurations are much smaller than the observed cross sections; core polarization effects are very strong. (auth)

44921 PROMPT NEUTRON EMISSION IN MEDIUM-EXCITATION FISSION OF URANIUM. Burnett, Sibley Charles. Knoxville, Tenn., Univ. of Tennessee, 1968. 110p.

Thesis.

The energetics of the fission of ^{233}U induced by 8.5- and 13-MeV protons and of ^{238}U induced by 12-MeV protons were studied by means of a three-parameter experiment. The time of flight of one fragment was measured in coincidence with the pulse amplitudes produced by both fragments in silicon surface barrier detectors. The average number of neutrons emitted from the individual fragments and from both fragments together are obtained as functions of fragment mass and total kinetic energy. The number of neutrons emitted per fragment increases with increasing fragment mass and the "sawtooth" shape characteristic of neutron emission in low-excitation fission is still apparent, although the relative depths of the minima in the present cases are reduced. The pre- and post-neutron-emission fragment mass distributions are obtained, together with the fragment energy distributions and mass versus energy correlations. The question of energy balance is studied by comparing the total energy available for fission into a given mass pair with the sum of the fragment excitation energies, calculated from neutron emission data and mass tables, and the measured fragment kinetic energies. In addition to experimental results, a discussion of errors and uncertainties in the energy-energy-time experiment is included. Problems such as dispersion effects and corrections for the effects of target thickness are discussed. (Diss. Abstr.)

44922 TOTAL NEUTRON CROSS SECTION OF ^{230}Th IN THE ENERGY REGION UP TO 600 eV. Kalebin, S. M.; Palei, P. N.; Ivanov, R. N.; Karalova, Z. K.; Kukavadze, G. M.; Pyzhova, Z. I.; Rukolaine, G. V. At. Energ. (USSR), 26: 507-12(June 1969). (In Russian).

The total neutron cross sections of ^{230}Th in the thermal and resonance energy region were measured in the ITEF heavy water experimental reactor. One gram of ^{230}Th was educed from uranic ore. The measurements were performed with a fast chopper suspended in the magnetic field. The total neutron cross section of ^{230}Th at the thermal point (0.025 eV) is (71.8 ± 2) barn, the neutron capture cross section is (56.8 ± 3), and the potential scattering cross section is (15 ± 2) barn. In the energy region up to 600 eV 29 neutron resonances, including one negative level, were measured. The parameters of the resonances are given. From the resonance parameters the neutron strength function and the resonance integral are calculated: $(1.30 \pm 0.3) \cdot 10^{-4}$ and (1035 ± 85) barn, respectively. The average neutron level spacings of ^{230}Th are (9.8 ± 1.6) eV. (auth)

44923 SPONTANEOUS FISSION OF LEAD: SEARCH FOR VERY DISTANT TRANSURANIUM ELEMENTS. Flerov, G. N.; Perelygin, V. P. At. Energ. (USSR), 26: 520-2(June 1969). (In Russian).

Tracks of nuclear fission fragments in Pb and its compounds were recorded by means of dielectric track detectors. For the lead glass this effect corresponds to the seemed spontaneous fission halflife of Pb $(2-3) \times 10^{20}$ years. Various possible sources of the effect being observed are analyzed. The assumption of existence of a long-lived spontaneously fissioning transuranic nuclide may serve as one of possible interpretations of the activity being supervised. (auth)

44924 ELASTIC AND INELASTIC SCATTERING OF NEUTRON-CAPTURE GAMMA RADIATION. Michalk, Victor Edward. College Station, Tex., Texas A and M Univ., 1968. 82p.

Thesis.

The complex scattering spectra resulting from neutron capture gamma irradiation of various targets were studied using a large-volume lithium-drifted germanium detector. Because of the improved resolution of Ge(Li) detectors, the inelastic peaks are resolved in the spectra. Transitions to low-lying states are compared to known low level energy schemes, and the isotopes responsible for resonance scattering are identified. Branching ratios are measured, and angular distribution measurements are made for some of the decay transitions to low-lying states. An E2, M1 mixture is observed for the decay transition of the 7.629-MeV level in ^{112}Cd to the first 2^+, 0.62-MeV state. This implies that the parity of the spin 1, 7.629-MeV level is even. (Diss. Abstr.)

44925 THE DETERMINATION OF THE NUCLEAR g FACTOR OF THE FIRST EXCITED STATE OF ^{102}Ru USING INTERNAL MAGNETIC FIELDS. Freeman, Robert Wyatt. Knoxville, Tenn., Univ. of Tennessee, 1968. 79p.

Thesis.

The nuclear g-factor of the first excited state of ^{102}Ru was determined by perturbed angular correlation methods. The radioactive source was diffused into an iron host and placed in a magnetic field to saturate the iron. This resulted in an effective magnetic field at the ruthenium nucleus $(5.00 \pm 0.020) \times 10^5$ gauss. The angular correlation pattern of the 475 keV, γ-ray in coincidence with the (1050, 1100) keV, composite γ-rays was rotated through an angle of -0.022 ± 0.014 radians in this magnetic field. From this rotation was derived a value of the nuclear g-factor of the 475-keV level in ^{102}Ru of $g = 0.38 \pm 0.25$. (Diss. Abstr.)

44926 INTERNAL CONVERSION STUDIES OF DOUBLE DECAY PROCESSES IN ^{114}In. Vukanovic, R.; Samuelsson, L.; Migahed, M.; Westerberg, L.; Edvardson, L. O. (Uppsala Univ.). Phys. Lett., 29B: 576-8(Aug. 4, 1969).

Coincident events, which satisfy the energy conditions for double internal conversion, are observed for the 192 keV transition in ^{114}In. Extrapolating to a zero thickness source, $T_{KK}/T_K = (1.7 \pm 0.3) \times 10^{-5}$ was obtained. (auth)

44927 NUCLEAR g-FACTOR OF THE 322 keV INTRUDER STATE IN ^{125}Te. Knapek, E.; Simon, R.; Raghavan, R. S.; Koerner, H. J. (Technische Hochschule, Munich). Phys. Lett., 29B: 581-2(Aug. 4, 1969).

The nuclear g-factor of the 322-keV state in ^{125}Te was measured to be $g = -0.202 \pm 0.016$, in agreement with the prediction for a three-quasiparticle intruder state $(h_{11/2}^3)_{\frac{9}{2}^-}$. (auth)

44928 BETA–GAMMA CORRELATIONAL STUDIES ON THE 1710 keV β^- – 86 keV γ CASCADE IN ^{160}Tb. Rao, V. Seshagiri; Lakshminarayana, V. (Andhra Univ., Waltair, India). Curr. Sci. (India), 38: 383-4(Aug. 20, 1969).

A conventional slow-fast scintillation assembly was used to measure the β-γ directional correlation in the 1710-keV β^- – 86-keV γ cascade in ^{160}Tb. (J.W.R.)

44929 ELECTROMAGNETIC TRANSITIONS IN NONAXIAL ODD NUCLEI. Kashuba, I. E.; Ovcharenko, V. I. (Inst. of Physics, Kiev. Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh., 14: 784-92(May 1969). (In Russian).

On the basis of the model of a non-axial odd nucleus, developed earlier by A. S. Davydov, R. A. Sardaryan and V. V. Pashkevich, numerical calculations of some reduced probabilities of E2- and M1-transitions and mean values of electric and magnetic dipole moments are carried out in adiabatic approximation by β- and γ-vibrations. A comparison of these values is made with experimental data for the nuclei ^{165}Ho, ^{167}Er, ^{175}Lu, ^{177}Lu, ^{177}Hf, and ^{181}Ta. A good agreement of the theory with the experiment is observed. (auth)

44930 FINE STRUCTURE IN NUCLEAR FISSION. PART I. YIELDS FROM 3- AND 14.8-MeV NEUTRON INDUCED FISSION OF ^{238}U AND ^{232}Th IN THE MASS REGION 131 TO 135. Lyle, S. J.; Sellars, J. (Univ. of Kent, Canterbury, Eng.). Radiochim. Acta, 12: 43-8(July 1969).

End-window proportional (for ^{97}Zr and ^{99}Mo) and gas (Geiger) counters (for ^{133,135}Xe) were used in the radiochemical determination of cumulative yields in the 3- and 14.8-MeV neutron induced fission of ^{238}U and ^{232}Th. Yields for the mass chains 131 to 134 from 14.8-MeV neutron induced fission of ^{238}U were measured by end-window counting of the appropriate iodine isotopes; a reliable value for mass 135 could not be obtained by this method because of loss of the ^{135}Xe daughter from palladium(II) [or silver] iodides. All measurements were made relative to mass 99. The results, with those previously published, were used in an examination of evidence for fine structure in the 131 to 135 mass region for 3- and 14-MeV neutron induced fission of ^{238}U and ^{232}Th. Present evidence suggests that fine structural features are reduced at the higher nuclear excitation energy and in thorium relative to uranium. (auth)

44931 TWICE FORBIDDEN BETA TRANSITION OF ^{137}Cs. Schneuwly, H.; Schellenberg, L.; Huber, O.; Lindt, W. (Univ., Fribourg, Switzerland). Helv. Phys. Acta, 42: 743-58(Aug. 15, 1969). (In German).

The spectrum of the twice parity-forbidden β-transition of ^{137}Cs was measured with two spectrometers of different types. The experimental shape factor was fitted with the one-parametric formula $S \propto q^2 + \lambda^2 p^2$ and the two-parametric ξ-approximation of the theoretical shape factor. With the hypothesis of CVC theory the ratio of nuclear matrix elements $\int 1 T_{ij} / \int R_{ij}$ is deduced. (auth)

44932 DELAYED-NEUTRON PRECURSORS. del Marmol, P. (CEN–SCK, Mol, Belg.). Nucl. Data, Sect. A, 6: 141-51 (June 1969).

For delayed-neutron precursors, i.e., nuclei whose β-decay populates neutron-emitting states of their daughters, experimental data on the following properties are compiled and evaluated: half-life, neutron-emission probability, charge and mass assignment, methods of production, β-decay properties leading to the neutron-emitting states, neutron spectra, measured or estimated β-disintegration energy of the parent, and neutron-separation energy of the daughter nucleus. (auth)

44933 PROMPT GAMMA-RAY EMISSION IN THE SPONTANEOUS TERNARY FISSION OF ^{252}Cf. Ajitanand, N. N. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys., A133: 625-9(1969).

The ratio of the yield of prompt gamma rays emitted in binary fission of ^{252}Cf to that emitted in ternary fission has been determined using a NaI(Tl) detector. A value of 1.16 ± 0.02 was obtained. The yield of gamma rays in ternary fission is found to increase with the alpha-particle energy for $E_\alpha > 17$ MeV. (auth)

44934 THE DECAY OF ^{214}Pb AND OTHER ^{226}Ra DAUGHTERS. Lingeman, E. W. A.; Konijn, J.; Polak, P.; Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A133: 630-47(1969).

Energies and relative intensities of gamma radiations following the decay of ^{226}Ra and its short-lived daughters have been measured using Ge(Li) detectors. A special study of the decay scheme of ^{214}Pb was made using a ^{214}Pb source from which the Bi daughter was eluted continuously. Earlier intensity discrepancies in its decay were solved. An improved scheme is also given for the decay of ^{214}Bi. (auth)

44935 K-FORBIDDEN ISOMERIC TRANSITION IN ^{130}Ba. Rotter, H.; Alexander, K. F.; Droste, Ch.; Morek, T.; Neubert, W.; Chojnacki, S. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A133: 648-52(1969).

The 8.8 msec isomeric state of ^{130}Ba was produced in the reaction ^{122}Sn(^{12}C,4n). It decays by a cascade of 4 transitions to the ground state. Delayed gamma-rays were measured with a Ge(Li) detector, conversion electrons with a magnetic beta-ray spectrometer. Multipolarities were deduced from intensity relations of K-conversion electron lines. The following results were obtained: 355.5 keV (assumed E2), 543.5 keV (E2), 690.0 keV (E2), 881.3 keV (M2). The isomeric state has $J^\pi = 8^-$ and decays by the 881.3 keV transition to the 6^+ state of the ground state rotational band. The large hindrance factor $F \approx 10^7$ s.p.u. is typical for a K-forbidden transition in a deformed nucleus. Possible two-quasiparticle configurations for the isomeric state are discussed. (auth)

44936 LEVELS IN ^{185}W FROM THE DECAY OF ^{185m}W AND ^{185}Ta. Kuroyanagi, T.; Tamura, Tsutomu (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys., A133: 554-71(1969).

Radiations from the decay of 1.6 min ^{185m}W and 49 min ^{185}Ta have been studied with Ge(Li), Si(Li) and Si surface barrier detectors. Decay schemes of ^{185m}W and ^{185}Ta are proposed. The conversion coefficients and multipolarity assignments for the transitions between the low-lying excited states of ^{185}W were obtained. All the transitions are placed in the level scheme of ^{185}W consisting of the intrinsic states of $3/2^-$(512) at 0 keV, $1/2^-$(510) at 23.6 keV, $11/2^+$(615) at 197.5 keV and $1/2^-$(503) at 243.7 keV, and their rotational members. The half-life of the 243.7 keV level in ^{185}W has been measured at 19.3 ± 0.5 ns. The absolute gamma-ray transition probabilities are compared with the Weisskopf estimate. The absolute gamma transition probabilities for the E2 transitions from the $1/2^-$(503) level to the $3/2^-$(512) band, are further compared with theoretical half-lives calculated from the Nilsson and the Faessler–Sheline wave functions. An attempt is made to give a qualitative explanation of the observed branching ratios by including the effect of the Coriolis band mixing. (auth)

44937 INTERACTION OF FAST NEUTRONS WITH ^{165}Ho. Fasoli, U. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Sambo, P.; Toniolo, D.; Zago, G.; Zuffi, L. Nucl. Phys., A133: 572-80(1969).

Differential elastic, inelastic and total neutron cross sections for ^{165}Ho have been measured at 3.0, 4.3, 6.0 and 7.5 MeV. The elastic scattering is analyzed in terms of the optical model using a coupled-channel calculation. The inelastic neutron energy spectra are analyzed in the framework of the statistical model. (auth)

44938 A STUDY OF THE DECAY SCHEME OF ^{134}I. Takekoshi, E.; Umezawa, H.; Suzuki, T. (Japan Atomic Energy Research Inst., Tokai). Nucl. Phys., A133: 493-504(1969).

The decay properties of ^{134}I obtained from fission products have been investigated with NaI(Tl) and Ge(Li) detectors. Energies (and relative intensities) of the gamma rays determined from the Ge(Li) detector and NaI(Tl)–Ge(Li) coincidence studies are 136(5.0), 236 (weak), 405(8.4), 433(4.2), 488(weak), 514(4.1), 541(9.8), 596(11.6), 622(10.3), 633(3.1), 644(weak), 677(7.7), 733(weak), 768(3.9), 848 (100.0), 859(6.1), 873(weak), 885(69.1), 905(weak), 923(weak), 948 (6.4), 976(5.4), 1041(3.2), 1073(17.1), 1103(2.3), 1138(11.8), 1458 (4.3), 1615(4.7), 1743(3.0) and 1810(6.2) keV. Gamma-ray coincidence spectra with the Ge(Li) detector were obtained with six gates; the lower half, the upper half and the total peaks of gamma-ray at 0.87 and 1.80 MeV in the NaI(Tl) gamma-ray spectrum. Anisotropy measurements for the 885–848, 1073–848 and 1138–885 keV cascades were carried out, and the possible spin sequences were given. A decay scheme is proposed with energy levels (and spins) in ^{134}Xe at 848(2^+), 1615(2^+), 1733(4^+), 1921(3,2) 2138, 2274, 2355, 2410, 2591, 2658, 2870(4,5), 3224 and 3379 keV. The levels, which are populated by strong beta groups, are also confirmed by a summing spectrum measurement. The half-life of ^{134}I was obtained to be 5.5 ± 0.1 min. (auth)

44939 NUCLEAR STRUCTURE EFFECTS IN THE PARTICLE PARAMETERS FOR THE 84.2 keV TRANSITION IN ^{231}Pa. Toernkvist, S.; Hasselgren, L.; Thun, J. E.; Marelius, A. (Univ. of Uppsala). Nucl. Phys., A133: 505-12(1969).

Particle parameters for the highly hindered 84.2 keV transition in ^{231}Pa have been shown to be influenced by dynamic nuclear structure effects. According to the theory by Pauli the nuclear current parameter η is found to be $\eta > 4$. (auth)

44940 ANGULAR CORRELATION OF THE 252-461 keV CASCADE IN ^{193}Ir. Rao, P. Brahmananda; Lakshminarayana, V. (Andhra Univ., Waltair, India). Indian J. Phys., 42: 621-2(Oct. 1968).

The sum-peak coincidence technique was used to measure the 251–461 keV cascade occurring between the 713-, 461-keV, and ground states of ^{193}Ir following the beta decay of ^{193}Os. Spin assignments of $5/2$ and $3/2$ are suggested for the 713- and 461-keV states respectively. (J.W.R.)

44941 HALF-LIFE MEASUREMENTS AND TRANSITION PROBABILITIES IN ^{172}Yb. Belt, R. A.; Kugel, H. W.; Jaklevic, J. M.; Funk, E. G. (Univ. of Notre Dame, Ind.). Nucl. Phys., A134: 225-40(1969).

The half-lives of the 78.7 keV, 1172 keV, and the 1263 keV states of ^{172}Yb populated in the decay of ^{172}Lu(6.7 d) were measured by the delayed coincidence method to be 1.58 ± 0.06 nsec, 8.14 ± 0.220 nsec and 0.49 ± 0.03 nsec, respectively. The energy selection was improved by using either a magnetic spectrometer or a triple coincidence arrangement. Transition rates were calculated using experimental gamma-ray intensities and theoretical internal conversion coefficients. The electric quadrupole moment for the rotational band at 1172 keV was found from the 91 keV transition probability to be $Q_0 = 7.5 \pm 0.5$ b. The transition probabilities for K-forbidden transitions from

the K = 3 band based at 1172 keV to the ground state band are discussed in terms of the Bohr–Mottelson and Mikhailov predictions. (auth)

44942 SHAPE FACTORS OF THE BETA SPECTRA OF ^{170}Tm, ^{186}Re, AND ^{188}Re. Van Der Werf, S. Y.; De Waard, H.; Beekhuis, H. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., A134: 215-24(1969).

The beta spectra of ^{170}Tm, ^{186}Re, and ^{188}Re have been investigated with an intermediate image spectrometer. In all three cases, the shape factors of the $1^- \rightarrow 2^+$ and $1^- \rightarrow 0^+$ transitions have been found to be approximately the same. (auth)

44943 HALF-LIFE MEASUREMENT OF THE 343.4 keV LEVEL IN ^{175}Lu. Hoejeberg, M.; Malmskog, S. G. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Phys., A134: 77-80(1969).

Great theoretical interest has recently been shown in the asymptotically forbidden $^5/_2{}^5/_2{}^+[402] \rightarrow {}^7/_2{}^7/_2{}^+[404]$M1 transitions in ^{181}Ta and ^{175}Lu. Half-lives of the $^5/_2{}^5/_2{}^+[402]$ level in ^{175}Lu have been reported which differ by more than a factor of 10. Using an electron-electron coincidence spectrometer the half-life of this level has been re-measured and a value of (0.26 ± 0.02) nsec has been established. (auth)

44944 LEVEL AND ISOMER SYSTEMATICS IN EVEN TIN ISOTOPES FROM ^{108}Sn TO ^{118}Sn OBSERVED IN Cd(α,xn) REACTIONS. Yamazaki, T.; Ewan, G. T. (Univ. of California, Berkeley). Nucl. Phys., A134: 81-109(1969).

The gamma-ray spectra observed when separated cadmium isotopes (A = 106–116) are bombarded by 28–50 MeV α-particles from the Berkeley 2.2 m cyclotron have been studied with Ge(Li) detectors. Levels in even tin isotopes produced by (α,xn) reactions are reported. The prompt and delayed spectra have been studied using nsec time analysis and the natural beam bunching of the cyclotron to give a zero of time. Isomers have been observed in ^{118}Sn with $t_{\frac{1}{2}}$ = 20 nsec, 230 nsec and >500 nsec, in ^{116}Sn with $t_{\frac{1}{2}}$ = 350 nsec and >500 nsec and in ^{114}Sn with $t_{\frac{1}{2}}$ > 500 nsec and in ^{112}Sn with $t_{\frac{1}{2}}$ = 14 nsec. The level and isomer systematics in the even tin isotopes are discussed. Levels in odd tin isotopes for A = 113 to A = 119 are also discussed. (auth)

44945 EXCITED STATES OF ^{116}Sn POPULATED BY THE (α,2n) REACTION. Chang, C.-h.; Hagemann, G. B.; Yamazaki, T. (Univ. of Copenhagen). Nucl. Phys., A134: 110-17(1969).

Spectra of prompt and delayed (≈μsec) gamma rays were observed from a target of ^{114}Cd bombarded with ≈20 MeV α-particles. At this energy, the (α-2n) reaction is dominant. Prompt internal conversion electrons were also observed. The angular distribution of prompt gamma rays with respect to the beam direction was measured. The multipolarity of several transitions has been established, and the lifetime of an isomeric transition was measured to be 0.75 μsec. The isomeric transition itself is probably not observed, but several cascades showed this characteristic time distribution. The transition is probably connected with either the $(h_{11/2})^2$ 10^+ or 8^+ state proposed in the level scheme at ≈3.3 MeV. (auth)

44946 CHEMICAL EFFECT ON THE HALF-LIFE OF ^{235m}U. Neve de Mevergnies, M. (Centre d'Etude de l'Energie Nucleaire, Mol-Donk, Belg.). Phys. Rev. Lett., 23: 422-5(Aug. 25, 1969).

The half-life of the low-energy isomeric state of ^{235}U produced by α decay of ^{239}Pu was measured as a function of various metallic environments. The results show a correlation between the half-life and the average electronegativity of the host metal. In addition, effects due to impurity diffusion of U in metals at room temperature are observed. (auth)

44947 DETECTION OF SPONTANEOUSLY FISSIONING ISOMER STATES. Nagy, Laszlo; Nagy, Tibor; Vinnay, I. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 17: 165-70(1969). (In Hungarian).

Pulsed neutron source plus time analyzer registration method is applied to search for spontaneously fissioning isomer states in ^{235}U and ^{238}U targets bombarded with 14 MeV neutrons. The experimental technique and the initial results are reported. (auth)

Nuclear Theory

Refer also to abstracts 43575, 43578, 43590, 44162, 44669, 44690, 44841, 44854, 44886, 44919, and 44941.

44948 (ANU-P–440) EXPERIMENTS WITH POLARIZED DEUTERON BEAMS. Nurzynski, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1968]. 13p. Dep.

Some research projects in nuclear physics which are feasible with deuteron beams with $E_d \leq 10$ MeV are described. (J.W.R.)

44949 (ITEF–659) TOWARD A THEORY OF RESONANCE REACTIONS IN THE REGION OF OVERLAPPING LEVELS. Kudryavtsev, A. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A formula is derived which describes the energy dependence of the reaction amplitude. It is shown that the total width of the giant resonance differs from the sum of partial widths by the nonlinear terms in the level density. (auth)

44950 CONFIGURATION REPRESENTATION OF NUCLEON INTERACTION IN THE SUPERFLUID MODEL OF THE NUCLEUS. Rybarska, V. (Wroclaw Univ.). Dokl. Akad. Nauk SSSR, 185: 73-5(Mar. 1, 1969). (In Russian).

The Hamiltonian of the superfluid model of the nucleus consists of a single-particle term and of an interaction between nucleons of the last unfilled shell. This interaction contains a paired and a multipole-multipole part. In the nucleus we do not know the nature of the interaction between nucleons, and pairing according to the quantum numbers of the last shell makes an assumption on the result of various unknown interactions between nucleons. A shell model with a spherical oscillator potential is considered. Nucleons of one kind are in the last shell, and pairing forces of particles with opposite projections interact between the nucleons. The expression obtained for the potential in this case leads to a nonlocal equation for the two-particle wave function, and the interaction between the particles depends on the form of the potential of the shell model. Thus it is concluded that a local, two-particle potential in x-space cannot be compared to pairing which acts only in the last unfilled shell. (TTT)

44951 A METHOD FOR THE ANALYSIS OF EXPONENTIAL DECAY CURVES. Paatero, Pentti (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 319, 1-60(June 1969).

The method presented can be used for the analysis of different kinds of measured distributions, by the use of different response matrices. Linearization of the nonlinear problem of determination of the decay constants is achieved by selecting a set or grid of fixed half-lives (previous information about the solution can and should be utilized in this selection); the measured decay curve is expressed as a sum with non-negative coefficients of exponentials with these half-lives. A computer subroutine is presented for the performance of this fit. The subroutine is general and can be used in the analysis of all kinds of measurements; for a complete program, about 4,000 to 8,000 words of computer memory are required. A discussion is given of different possibilities of error: systematic, statistical, and component identification. Explicit expressions are presented, in terms of the covariance matrix of the fit, for the systematic and statistical errors of the results produced by the method, along with numerical examples. A measurement of the decay of ^{129}Ba is analyzed as an example. (auth)

44952 BEHAVIOR OF CROSS SECTIONS NEAR THE THRESHOLD OF REACTIONS WITH GIANT-RESONANCE FORMATION. Kudryavtsev, A. E. JETP Lett. (USSR) (Engl. Transl.), 9: 317-19(May 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 523-6(May 5, 1969).

The behavior of the cross sections of reactions in an energy interval in which there exists a set of excitation thresholds of unstable particle states having common decay channels is analyzed. (J.W.R.)

44953 FADDEEV EQUATIONS WITH A SUM OF SEPARABLE AND NON-SEPARABLE POTENTIALS. Yaes, Robert J. (Univ. of Helsinki). Nucl. Phys., A131: 623-35(1969).

The two-body T-matrix for the sum of a separable potential V and a nonseparable potential V′ is shown to be the sum of the T-matrix for V′ and a separable term with energy-dependent form factors. The Faddeev equations then reduce to a set of coupled Lippmann–Schwinger type equations. Resolvent identities are used to develop a perturbation theory for expanding the three-body T-matrix, bound-state wave functions and binding energies in powers of V′. Some examples are discussed. (auth)

44954 GENERALIZED SHELLS IN DEFORMED NUCLEI. Griffin, James J. Comments Nucl. Particle Phys., 3: 58-65 (Mar.-Apr. 1969).

Evidence for generalized shell structure in deformed nuclei is discussed. Recent developments relating to long-lived fissioning isomers which offer promise for the development of nuclear structure theory are summarized. (J.W.R.)

44955 DELAYED NUCLEAR FISSION. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 185: 1025-7(Apr. 11, 1969). (In Russian).

In heavy nuclei, the β-decay energy Q_β may be higher than the fission barrier of the daughter nucleus and β decay to an excited state above the barrier B_f may be accompanied by fission. Delayed fission may occur within ranges, at which certain conditions of the half-life of the parent nucleus with respect to α and β decay and spontaneous fission are fulfilled. In such a case, the specific fission time from the excited state does not exceed about 10^{-14} sec. Even slight changes in the barrier, by about 0.5 MeV, may change the spontaneous fission half-life by 3 to 4 orders of magnitude. The study indicated that delayed fission may occur in a wide range of neutron-excess nuclei which are synthesized in supernovae and, to a lesser extent, in thermonuclear explosions. Delayed fission may be observed only in a small number of proton-excess nuclei; it may also occur in superheavy nuclei with $Z \approx 114$ and 126. (TTT)

44956 DIRECT EXPERIMENTAL INVESTIGATION OF THE AVERAGE ELECTRIC FIELD GRADIENT AT THE NUCLEAR SITE AND THE DETERMINATION OF THE STATIC ELECTRIC QUADRUPOLE MOMENT OF THE EXCITED STATE OF A NUCLEUS. Sen, S. K. (Univ. of Manitoba, Winnipeg). Nucl. Instrum. Methods, 72: 321-4(1969).

A new experimental method is proposed to determine directly the average electric field gradient prevailing at the site of a nucleus including the Sternheimer effect, and the static electric quadrupole moment of an excited state of a nucleus. The method would be useful for better understanding of the internal electric fields in solids. (auth)

44957 ON K- AND L-CAPTURE RATIO PROBABILITIES. Zyryanova, L. N.; Suslov, Yu. P. (Leningrad State Univ.). pp 45-50 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

Calculations of the ratio of K- and L-capture probabilities are discussed and compared with experimental values. Certain differences are noted which are not explained by overlap and exchange corrections. (J.W.R.)

44958 FUNCTIONS FOR THE ANALYSIS OF K- AND L-ELECTRON CAPTURE. Suslov, Yu. P. (Leningrad State Univ.). pp 51-60 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

Tables are presented for the analysis of K- and L-capture which were obtained with the nonrelativistic self-consistent field potential with exchange effects. The nuclear finite size was taken into account by treating the nucleus as a finite charged sphere with $R_0 = 1.2\ A^{\frac{1}{3}}$ F. (J.W.R.)

44959 ELECTRON CAPTURE RATIOS. Behrens, H. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.); Buehring, W. pp 61-5 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The one-electron Dirac radial equations were solved numerically for a potential corresponding to an extended nuclear charge distribution screened by the atomic electrons. The results were applied to L/K and M/L electron capture and poor agreement was found with experimental data. (J.W.R.)

44960 THE CALCULATION OF ORBITAL ELECTRON CAPTURE RATIOS USING HARTREE-FOCK WAVE FUNCTIONS. Winter, Georg (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 66-70 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The L/K electron density ratio was calculated using analytical Hartree–Fock wave functions and taking into account relativistic corrections. (auth)

44961 EXCHANGE CORRELATION IN ELECTRON CAPTURE. Vatai, E. (Inst. of Nuclear Research, Debrecen, Hungary). pp 71-5 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

It is shown that proper exchange correlations may remove the discrepancies between experimental and theoretical exchange and overlap corrected L/K ratios. (J.W.R.)

44962 ON THE INFLUENCE OF THE NUCLEUS SHAPE CHANGE ON THE ELECTRON CAPTURE AND BETA DECAY PROBABILITIES. Berlovich, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). pp 76-80 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

Experimental log ft values for beta and electron-capture decays in the region of nuclear shape changes were examined to determine the influence of shape changes on decay probabilities. It was found that probabilities for decays involving a nuclear shape change were reduced considerably. (J.W.R.)

44963 CAPTURE PROBABILITY FOR K-, L-, AND M-ATOMIC ELECTRONS (SURVEY). Zyryanova, L. N. (Leningrad State Univ.). pp 5-22 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 1. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.1).

The theoretical values of capture probabilities for K-, L-, and M-atomic electrons both for allowed and forbidden transitions are discussed. A tendency toward discrepancies between theoretical and experimental capture ratios is noted. The calculations of exchange corrections are discussed. (J.W.R.)

44964 PROCEEDINGS OF THE CONFERENCE ON THE ELECTRON CAPTURE AND HIGHER ORDER PROCESSES IN NUCLEAR DECAYS, DEBRECEN, HUNGARY, JULY 15–18, 1968. VOLUME 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. 229p. (CONF-680703-(Vol.3)).

Separate abstracts were prepared for 27 papers included in this volume. The remaining paper has previously appeared in NSA. (J.W.R.)

For abstracts of individual papers see: 44152, 44174, 44832–44834, 44861, 44862, 44901–44910, 44965–44968, and 44976–44981.

44965 MUON CAPTURE BY COMPLEX NUCLEI. Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 269-90 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The theory of meson (μ^-) capture by complex nuclei is discussed. The use of model and phenomenological bases to describe nuclear transitions following muon capture is examined. Both methods are used to study muon capture by ^{3}He, ^{12}C, and ^{16}O. The neutron emission process in muon capture is also discussed. (J.W.R.)

44966 PION CAPTURE. Daniel, H. (Max Planck Inst. of Nuclear Physics, Heidelberg. CERN, Geneva). pp 291-306 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The properties of pionic atoms are reviewed and compared with muonic atoms. The strong and electromagnetic interactions in pion capture are examined. The experimental techniques used in studying pionic atoms are described and some results of studies on pionic atoms and the capture mechanism are surveyed. (J.W.R.)

44967 RADIATIVE CAPTURE OF MUONS AND THE WEAK INTERACTION STRUCTURE. Lobov, G. A. (Inst. for Theoretical and Experimental Physics, Moscow). pp 307-20 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The use of the muon radiative capture process for studying the muon-nucleon interaction is discussed. The muon capture process in simple nuclei is examined in detail. It is shown that the strong dependence of effects concerning the weak interaction renormalization contents can be used experimentally to establish the type of interactions between muons and nucleons. (J.W.R.)

44968 CORRELATIONS OF NEUTRINO AND NUCLEAR GAMMA-QUANTUM FROM MUON CAPTURE. Popov, N. P. (Ioffe Inst. of Physics and Tech., Leningrad). pp 321-4 of Pro-

ceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

Experiments on muon capture with the formation of a daughter nucleus in an excited state are discussed. The information that may be obtained on the coupling constants by studying the neutrino-gamma correlations is described. (J.W.R.)

44969 A COMPUTER (GIER-ALGOL) PROGRAM FOR COMPUTING ELECTRON AND POSITRON WAVE FUNCTIONS. Vinduska, M. (Inst. of Nuclear Research, Rez, Czech.). pp 248-52 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

A computer program was written for computing electron and positron wave functions with phases. The code employs either a uniformly charged spherical model or a Fermi nuclear charge density distribution. The screening function outside the nucleus can be given numerically or analytically. Calculations were performed for several values of Z and compared with other results. (J.W.R.)

44970 ELECTRON CAPTURE TO POSITRON EMISSION RATIOS. Depommier, P. (Institut des Sciences Nucleaires, Grenoble, France). pp 202-21 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The interdependence of atomic physics, nuclear physics, and weak interaction theory in studying the electron capture process is discussed. The importance of the atomic wave functions, the weak interaction mechanism, and nuclear structure effects in study electron-capture to positron emission ratios is described. Some of the experimental and theoretical work on electron-capture to positron emission ratios is reviewed. (J.W.R.)

44971 LATEST DATA FOR K/β^+ BRANCHING RATIO VALUES. Zyryanova, L. N.; Suslov, Yu. P. (Leningrad State Univ.). pp 234-43 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol. 2).

Theoretical calculations of K/β^+ ratios for allowed transitions are compared with experimental data. The comparison verifies the influence of exchange effects. (J.W.R.)

44972 PROCEEDINGS OF THE CONFERENCE ON THE ELECTRON CAPTURE AND HIGHER ORDER PROCESSES IN NUCLEAR DECAYS, DEBRECEN, HUNGARY, JULY 15–18, 1968. VOLUME 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. 148p. (CONF-680703-(Vol.2)).

Separate abstracts were prepared for the 18 papers included in this volume. (J.W.R.)

For abstracts of individual papers see: 44162, 44835, 44855–44860, 44897–44900, 44969–44971, and 44973–44975.

44973 INTERNAL BREMSSTRAHLUNG IN ELECTRON CAPTURE. Zylicz, Jan (Inst. of Nuclear Research, Swierk, Poland). pp 123-41 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

Progress in theoretical and experimental studies on electron capture accompanied by internal bremsstrahlung is outlined. (J.W.R.)

44974 INTERNAL BREMSSTRAHLUNG IN β-DECAY. Persson, Boerje I. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. pp 142-58 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968. (CALT-63-101).

See CONF-680703-(Vol.2).

The theory of internal bremsstrahlung in beta decay is reviewed. The measured spectral distributions of internal bremsstrahlung from the most extensively studied β decays are compared and discussed in the framework of appropriate theoretical calculations. The inconsistencies among the experimental data and the uncertainty of the validity of the theoretical calculations are pointed out. (J.W.R.)

44975 THEORY OF FORBIDDEN RADIATIVE ELECTRON CAPTURE. Rapoport, L. P.; Zon, B. A. (Voronezh State Univ., USSR). pp 159-62 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 2. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.2).

The theory of forbidden radiative electron capture, developed using the techniques of spherical tensor operators, is discussed. Theoretical calculations for ^{36}Cl are compared with experimental values. (J.W.R.)

44976 ON THE SHAPE OF THE NUCLEI IN TRANSITION REGIONS. Berlovich, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). pp 444-52 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The properties odd-A nuclei in the region of comparable deformation and pairing energies are described. The evidence supporting two different physical causes for abrupt changes in nuclear shape with changing nucleon number is discussed. (J.W.R.)

44977 INVESTIGATION OF THE HIGHLY RETARDED ALLOWED β TRANSITIONS. Subotowicz, M. (Marie Curie-Sklodowska Univ., Lublin). pp 423-30 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15-18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The nuclear structure factors and higher order effects in allowed beta decay are discussed. Formulas for shape factors and directional correlation coefficients are described and some calculations reviewed. (J.W.R.)

44978 ON THE EXISTENCE OF DIRECTIONAL CORRELATIONS INVOLVING K X RAYS IN NUCLEAR DECAYS. Sen, S. K. (Univ., Bonn). pp 406-11 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

It is suggested that, in some special cases, a small anisotropy could be detected in the directional correlation measurements between the K-conversion electrons and the accompanying X-rays. (auth)

44979 ATOMIC ELECTRON CORRELATIONS AND INTERNAL CONVERSION PROCESS. Amusya, M. Ya.; Listengarten, M. A.; Shapiro, S. G. (Leningrad State Univ. Ioffe Inst. of Physics and Tech., Leningrad). pp 412-17 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

The role of many-body effects in the internal conversion process is discussed. Internal conversion coefficients which take into account many-electron correlations are compared with those calculated in the single-particle approximation. (J.W.R.)

44980 REARRANGEMENT OF ATOMIC ELECTRONS DURING BETA DECAY. Crasemann, Bernd (Univ. of Oregon, Eugene); Stephas, Paul. pp 349-67 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen, Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703-(Vol.3).

When an atom undergoes radioactive decay and its nuclear charge days from Z to Z', the atomic electrons undergo transitions from eigenstates of the parent to eigenstates of the daughter atom. Atomic excitation and ionization during β decay produced during this process are discussed. Theoretical approaches are outlined, with emphasis on the approximations they imply. Internal ionization through Coulomb scattering of bound electrons by the emitted β particle is briefly reviewed. Problems that arise in the interpretation of experiments on internal ionization are discussed, and theoretical predictions regarding observable quantities are derived. Some available data are briefly reviewed, and further work is suggested. (auth)

44981 HIGHER-ORDER ELECTROMAGNETIC TRANSITIONS IN NUCLEI. Leisi, H. J. (Federal Inst. of Tech., Zurich). pp 368-81 of Proceedings of the Conference on the Electron Capture and Higher Order Processes in Nuclear Decays, Debrecen,

Hungary, July 15–18, 1968. Vol. 3. Berenyi, D. (ed.). Budapest, Eoetvoes Lorand Physical Society, 1968.

See CONF-680703–(Vol.3).

Higher-order processes in electromagnetic transitions in nuclei are discussed. The processes include monoenergetic positron formation, two-photon decay, γ-e emission, and double internal conversion. The available experimental data on these processes are summarized. (J.W.R.)

44982 ELECTRIC QUADRUPOLE TRANSITIONS IN DEFORMED ODD NUCLEI. Begzhanov, R. B.; Isakov, B.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 1, 43-8(1969). (In Russian).

In addition to changes in the arrangement of levels, the taking into account of the deformation of the nucleus also has a substantial effect on the probabilities of the electromagnetic transitions between excited levels. The effect of the deformation of an odd nucleus on the reduced probabilities of E2-transitions within the ground, rotational-single particle band and of transitions between levels of the first rotational-single particle-beta-oscillatory and the ground, rotational-single particle bands is considered. An expression is written for the wave function of excited states of deformable, non-spherical, odd nuclei. Excited states of a quadrupole type in these nuclei are a complex combination of collective and single particle excitations. The deformation of the nucleus is taken into account by inclusion of a separate multiplier. The deformation of the nucleus during excitation has a significant effect on the excited states. Thus the results of the calculations show that at $\mu < 0.2$ (rigid nuclei) the energy levels, arrangement of spins and the reduced probabilities of the E2-transitions differ slightly from the theoretical values which do not take into account the deformation of the nucleus during excitation. At $\mu > 0.2$ the taking into account of the deformation of odd nuclei of ^{193}Au, ^{195}Au, and ^{197}Au has a substantial effect on the energy values of the levels, the arrangement of spins and the probabilities of the E2-transitions. The corrections are particularly significant in soft nuclei when $\mu > 0.4$. (TTT)

44983 GENERALIZATION TO ARBITRARY GROUPS ON THE RELATION BETWEEN SENIORITY AND QUASISPIN. Moshinsky, M.; Quesne, C. (Univ., Mexico, Mexico City). Phys. Lett., 29B: 482-4(July 21, 1969).

A group which plays the same role with respect to the ordinary rotation group $O^+(3)$ as the quasispin group $SU^Q(2)$ plays with respect to the symplectic group $Sp(2j + 1)$ is discussed in a shell of angular momentum j. The concepts generalize to other groups and to more complex configurations. (auth)

44984 THE SINGLE PARTICLE γ-TRANSITION PROBABILITIES IN THE SPHERICAL HARMONIC OSCILLATOR POTENTIAL. Sugimitsu, Tsuyoshi Mem. Fac. Sci., Kyushu Univ., Ser. B, 4: 11-29(Dec. 1968).

The single-particle γ-transition probabilities in the spherical harmonic oscillator potential are calculated and tabulated for each transition between shell model orbits. The usually neglected statistical factor is taken into account. (J.W.R.)

44985 APPLICATION OF THE CORRELATED BASIS FUNCTION METHOD TO EXTENDED NUCLEAR SYSTEMS. Chakkalakal, Dennis Abraham. St. Louis, Washington Univ., 1968. 144p.

Thesis.

The correlated basis function method of J. W. Clark and P. Westhaus (Phys. Rev. 141, 833 (1966)) which uses a Jastrow basis is applied to neutron matter and symmetrical nuclear matter. The study of neutron matter, in addition to being of astrophysical interest, also aids in the understanding and development of a practical method (within the CBF formalism) for nuclear matter calculations. The ground state energy $E_0(P)$ of each of these systems is calculated as a function of the particle density P. Numerical results are obtained using the (1) IY (F. Iwamoto and M. Yamada, Progr. Theoret. Phys. (Kyoto) 18, 345 (1957), (2) OMY (T. Ohmura, M. Morita, and M. Yamada, Progr. Theoret. Phys. (Kyoto) 15, 222 (1956), (3) BGT (K. A. Brueckner and J. L. Gammel, Phys. Rev. 109, 1023 (1958), and (4) HJ (T. Hamada and I. D. Johnston) potentials. The noncentral components of the last two are neglected in the calculation. These results are compared with the previous calculations of Tso-pin Wang (Ph.D. thesis, Washington University, 1966 (unpublished)) and P. Westhaus (Ph.D. thesis, Washington University, 1966 (unpublished)). For nuclear matter, the IY potential gives a ground state energy per particle of $E_b = -6.4$ MeV at an equilibrium density of $k_F^0 = 1.36$ fm^{-1}. The OMY potential gives $E_b = -14.3$ MeV at $k_F^0 = 1.58$ fm^{-1}. The compressibility modulus in these two cases is estimated to be 103 MeV and 117 MeV respectively. The central part of the HJ potential fails to give binding. Finally, a modification of the Clark–Westhaus formalism for calculating the effects of some noncentral correlations is developed. Using this, preliminary estimates of the contribution to the energy per particle arising from the tensor force are obtained. (Diss. Abstr.)

44986 DESCRIPTION OF PAIRING VIBRATIONS WITH THE GENERATOR COORDINATE METHOD. Justin, D.; Mihailovic, M. V.; Rosina, M. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Phys. Lett., 29B: 458-60(July 21, 1969).

The family of N-projected BCS functions $\Phi^N_{BCS}(x,t)$ with u and v depending on a single generator parameter t in an appropriate way, spans the linear subspace $\mathcal{N}_\Phi$ containing pairing vibrational states. An approximation is formulated, in which the subspace $\mathcal{N}_\Phi$ is truncated to much smaller dimension by orthogonalizing the basis Φ^N_{BCS} and by rejecting the new basic vectors with small norm. (auth)

44987 ON THE IMPORTANCE OF ELASTIC AND INELASTIC CHANNEL CONTRIBUTIONS TO EXTERNAL MIXING. Mekjian, A. Z. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 29B: 461-4(July 21, 1969).

The elastic and inelastic channel contributions to the isospin impurity of an analog state wave function is considered from a shell model description. The on and off resonance behavior of these contributions is discussed. The inelastic channel contributions are found to be more important in the wings of an analog resonance than near the analog state resonance energy. (auth)

44988 VARIATIONAL METHOD WITHOUT WAVE FUNCTIONS IN THE NUCLEAR MANY-BODY PROBLEM. Dreiss, G. J. (Northeastern Univ., Boston); Klein, A.; Pang, S. C. Phys. Lett., 29B: 465-7(July 21, 1969).

Expectation values of the Hamiltonian, expressed as sum rules in terms of physically observable transition elements, are considered as variational expressions subject to sum sule constraints. The latter are derived from the Lie algebra of the transition operators and from Pauli principle restrictions. The power and flexibility of the method is illustrated by an example. (auth)

44989 A MONTE CARLO PROGRAM FOR DOPPLER SHIFT ANALYSIS. Currie, W. M. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 73: 173-85 (1969).

A Monte Carlo program has been written which uses the Lindhard theory for heavy ion stopping powers to compute the attenuated γ-ray line shapes observed in the Doppler shift attenuation method of measuring nuclear lifetimes. The program has been tested extensively and the results are compared with the multiple scattering theory developed by Blaugrund. The validity of Blaugrund's formalism is established and his method is shown to be reliable for the analysis of centroid shift measurements. But the Monte Carlo procedure is superior for computing line shapes. The program is also useful for calculating other distributions dependent on multiple scattering, e.g., ranges and angular distributions. It is written in Fortran IV and is suitable for use on small data processors. (auth)

44990 TABLES OF FRACTIONAL PARENTAGE COEFFICIENTS IN THE ISOSPIN FORMALISM FOR THE j = 3/2 AND 5/2 SHELLS. Towner, I. S. (Nuclear Physics Lab., Oxford); Hardy, J. C. Nucl. Data, Sect. A, 6: 153-234(June 1969).

Values of one- and two-particle coefficients of fractional parentage in the isospin formalism were computed for the j = 3/2 and 5/2 shells. These values are tabulated for the first half of each shell. For the second half particle-hole formulas are quoted by which the coefficients of fractional parentage may be readily obtained. (auth)

44991 SUM RULES IN MODEL OF A NONAXIAL ODD NUCLEUS. Kashuba, I. E.; Ovcharenko, V. I. (Inst. of Physics, Kiev, Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh., 14: 793-805(May 1969). (In Russian).

In terms of the model of a non-axial odd nucleus, developed earlier by A. S. Davydov, V. V. Pashkevich and R. A. Sardaryan, sum rules are obtained in adiabatic approximation by β- and γ-vibrations for energy levels, mean values of electric quadrupole and magnetic dipole moments of states and reduced probabilities of E2- and M1-transitions. These rules enable one to draw a series of conclusions as to the observable values without making a considerable body of numerical calculations. (auth)

44992 NUCLEAR ROTATION AND THE RANDOM-PHASE APPROXIMATION. Marshalek, Eugene R. (Univ. of Notre Dame, Ind.); Weneser, Joseph. Ann. Phys. (N. Y.), 53: 569-624(July 1969).

A review is presented of the extraction of the rotational energy and corresponding collective coordinate within the formalism of

the random-phase approximation (RPA) for a two-dimensional deformed "nucleus." An intrinsic difficulty is observed: The random-phase approximation to the angular-momentum operator appears to have a continuous rather than discrete spectrum. Correspondingly, the RPA Hamiltonian has a continuum of unnormalizable eigenstates. A diagnosis of the origin of this difficulty is presented and a method to deal with it is proposed. It then becomes possible to calculate matrix elements of static and transition operators, and illustrative examples are given. Similar difficulties are also encountered in mechanical small-oscillation theory; simple examples are used to illustrate and motivate the procedures applied to the nuclear RPA problem. In the latter connection, the recent general formulation of rotational motion due to Villars is used as a convenient formal framework. Next, the relation between the RPA and the self-consistent cranking (constrained Hartree–Fock) model is simply exhibited, and subsequently it is shown that Kelson's "external consistency criteron" is fulfilled up to terms that are of the order of corrections to the RPA itself. (auth)

44993 ON MULTIPLE EXCITATION NEAR THE COULOMB BARRIER. Lukyanov, V. K. (Joint Inst. for Nuclear Research, Dubna, USSR); Gridnev, K. A.; Zvonov, V. S. Phys. Lett., 29B: 535-7(Aug. 4, 1969).

Near the Coulomb barrier the nuclear interaction was taken into account together with the Coulomb one, to investigate the influence of nuclear forces on the multiple excitation probabilities. It turns out that these probabilities are very sensitive to the nuclear surface parameters. As an example, some calculations were performed and reasonable agreement was obtained with the existing experimental data. (auth)

44994 PHONON MODEL DESCRIPTION OF SPHERICAL NUCLEI. Ogata, H. (Univ. of Windsor, Ont.); Akiyama, Y. Phys. Lett., 29B: 558-61(Aug. 4, 1969).

A completely numerical quadrupole phonon model calculation enables one to obtain a satisfactory description of anharmonic energy levels, reasonable B(E2) ratios and quadrupole moment ratios for even-even spherical nuclei. The failure of the random phase approximation is clarified. (auth)

44995 PENETRATION FACTORS AND RESONANCE MIXING PHASES FOR ISOBARIC ANALOG STATES. Thompson, W. J. (Florida State Univ., Tallahassee). Nucl. Data, Sect. A, 6: 129-40(June 1969).

Graphs are presented of penetration factors, P_n, to enable neutron spectroscopic factors, S, to be evaluated directly from proton elastic- and inelastic-scattering isobaric-analog-resonance partial widths, Γ_p, according to the relation $S = (N + 1 - Z)\Gamma_p P_n$, where N and Z are the numbers of target neutrons and protons, respectively. Also presented are graphs of the resonance mixing phase, ϕ_c^R, which is required in the extraction of Γ_p from data. The Z-range is 16 to 82 in varying steps convenient for interpolation. The angular momentum range is L = 0 (1) 4, J = L ± ½ (J > 0). A standard set of optical-model parameters is used. (auth)

44996 ELECTRON-INDUCED CASCADE SHOWERS IN INHOMOGENEOUS MEDIA. Yuda, T. (Nagoya Univ., Japan). Nucl. Instrum. Methods, 73: 301-12(1969).

The average behavior of a cascade shower initiated by a 1000 MeV electron in the layers of lead and acryl resins, lead and air gap is investigated using the photo-sensitive films. The above materials are chosen to examine the distortion of shower development due to the energy absorption and the geometrical spread in the spacer. Results obtained are compared with the experimental results for homogeneous media, conventional shower theory and the Monte Carlo calculations. The agreement between the experimental results and the Monte Carlo results is satisfactory. From this analysis, it is concluded that the dilution approximation is fairly good for the treatment of the shower in these materials. (auth)

44997 PROTON AND NEUTRON DISTRIBUTIONS CALCULATED USING AN EFFECTIVE SINGLE-PARTICLE POTENTIAL. Batty, C. J. (Rutherford High Energy Lab., Chilton, Eng.); Greenless, G. W. Nucl. Phys., A133: 673-90(1969).

An effective single-particle potential has been obtained which gives a best least-squares fit to the positions of the single-particle and single-hole states of ^{208}Pb. The predicted r.m.s. radii for the proton and neutron distributions and the angular distributions for electron scattering at 175 and 250 MeV are in very good agreement with measured values. With the same geometrical form, the level positions for ^{40}Ca and ^{48}Ca have also been fitted and again the predicted r.m.s. radii for the proton distribution and the electron scattering angular distribution are in good agreement with experiment. Using this same standard geometry and adjusting the strength of the central potential to give the separation energy, the predicted r.m.s. radii for the proton distributions for 16 < A < 208 are in very satisfactory agreement with measured values for nuclei close to the stability line. Some calculations using a non-local potential are also reported. For ^{208}Pb and ^{48}Ca, a best fit is obtained with a purely local potential. For ^{40}Ca, the best fit requires a nonlocality range of approximately 1 fm for both neutrons and protons. (auth)

44998 GENERALIZED DIFFRACTION MODEL FOR ONE- AND TWO-NUCLEON TRANSFER REACTIONS. Frahn, W. E.; Sharaf, M. A. (International Atomic Energy Agency, Trieste, Italy). Nucl. Phys., A133: 593-609(1969).

The amplitude for one- and two-nucleon transfer reactions in distorted-wave Born approximation is evaluated by means of a generalized diffraction method. In this method, the distortion in the initial and final channels is described in terms of parametrized phase shifts for elastic scattering. The differential cross sections are given by simple closed expressions, which display the kinematic features characteristic of direct reactions between strongly absorbed particles. The results are illustrated by typical examples. (auth)

44999 NUCLEAR MATRIX ELEMENTS DEDUCED FROM N–N PHASE SHIFTS. Koo, E. Ley (Univ. de Mexico, Mexico City); de Llano, M.; Grillot, D. V.; McManus, H. Nucl. Phys., A133: 610-24(1969).

A method suggested by Koltun of matching two-nucleon energies and wave-function logarithmic derivatives is employed to deduce nuclear matrix elements directly from the energy dependence of N–N scattering phase shifts without specifying the N–N potential function. Tensor coupling is treated exactly and expressed directly in terms of the scattering data. Both the 1968 Yale and 1962 Hamada–Johnston phase shifts were used. The matrix elements were also computed by numerical integration of the coupled Schroedinger radial equations with a HJ potential. Results are compared and discussed. The remarkable agreement obtained between the two methods improves sensibly with increasing nuclear size (decreasing oscillator energy $\hbar\omega$). (auth)

45000 NUCLEON–NUCLEON POTENTIAL AND MINIMAL RELATIVITY. Brown, G. E.; Jackson, A. D.; Kuo, T. T. S. (State Univ. of New York, Stony Brook). Nucl. Phys., A133: 481-92(1969).

The effects of relativistic elastic unitarity on low-energy nucleon–nucleon scattering and the binding energy of nuclear matter are investigated. Relativistic unitarity is found to increase the nuclear matter binding by approximately 0.5 MeV per particle over the value obtained for a nonrelativistic potential having a similar shape and identical phase shifts. (auth)

45001 TEST OF THE NEW TABAKIN N–N SEPARABLE POTENTIALS IN THE 3-N SYSTEM. Alessandrini, V. A. (International Centre for Theoretical Physics, Trieste, Italy); Garcia Canal, C. A. Nucl. Phys., A133: 590-2(1969).

A new set of rank one nucleon-nucleon separable potentials, which contain both a short-range repulsion and a long-range attraction suggested by Tabakin, are studied by using them in solving the Faddeev equations for the three-nucleon system. (auth)

45002 APPLICATION OF THE PROJECTED HARTREE–FOCK MODEL TO ^{21}Ne. Johnstone, I. P. (Univ. of Maryland, College Park); Benson, H. G. Contract ORO-3765-18. Nucl. Phys., A134: 68-76(1969). (ORO-3765-18).

Energy levels of ^{21}Ne are calculated by projecting states of good angular momentum from low-lying Hartree-Fock configurations. With the Kuo effective interaction and an E2 effective charge of 0.4e the normal-parity spectrum and the decay scheme are in fairly good agreement with experiment, although some of the calculated lifetimes appear to be too short. The model gives no even-parity state which can be identified with the 2.791 MeV level, and it is shown that its lifetime and decay characteristics are consistent with it being an odd-parity state having a hole in the 1p shell. (auth)

45003 K-SHELL INTERNAL CONVERSION COEFFICIENTS. Chattarji, Dipankar; Talukdar, Benoy (Visva-Bharati Univ., West Bengal, India). Nucl. Phys., A134: 199-208(1969).

K-shell internal conversion coefficients have been obtained for E1 and M1 transitions in the point nucleus limit by using solutions of the Biedenharn symmetric Dirac–Coulomb Hamiltonian. Numerical results obtained for atoms having Z values between 20 and 65 with γ-ray energies from 0.15 MeV to 2.5 MeV are compared with results of earlier calculations. (auth)

45004 POLARIZATION OF SPIN-HALF PARTICLES. Gubkin, I. A. (Leningrad State Univ.). Nucl. Phys., A134: 209-14(1969).

Formulas for the cross section and polarization of nucleons

elastically scattered at large angles are obtained from the optical model assumptions using a semiclassical approximation. The formulas thus obtained agree well with experimental data. (auth)

45005 NEUTRON PAIRING STATES IN DOUBLY EVEN NUCLEI. Soerensen, Bent (Univ. of California, Berkeley). Nucl. Phys., A134: 1-59(1969).

Neutron $J = 0$ states in even-N nuclei are calculated with a pairing force, using the boson expansion method. All regions of isotopes which are close to a fairly good shell-closure are covered, and a comparison is made between calculated and experimental two-nucleon transfer cross sections. In general it was found that a remarkably good agreement, even for the ground state mass systematics, suggesting that for the isotopes under consideration the simple pairing intersection is the dominant producer of ground state correlations. A lack of agreement with experiments in certain regions is proposed to be connected with couplings to definite other degrees of freedom under the influence of predominantly particle-hole interactions. (auth)

45006 ANGULAR CORRELATIONS BETWEEN MOMENTUM TRANSFER AND EMITTED NUCLEAR FRAGMENTS IN PHOTOABSORPTION, ELECTRON SCATTERING, AND MUON CAPTURE: ^{4}He. Crone, Lawrence (Catholic Univ. of America, Washington, D. C.); Werntz, Carl. Nucl. Phys., A134: 161-79(1969).

The giant dipole region of nuclear excitation plays an important role in photo-absorption, electron scattering and muon capture, and in this region there are many overlapping levels of the same and different J^π. Expressions are derived for the angular correlations of emitted nuclear fragments using R-matrix theory to describe the nuclear scattering states and reduced multipole moments to describe the electromagnetic or weak interactions. Application of the formulas to the processes in ^{4}He is presented, and it is shown that one of two previously proposed level schemes is unacceptable. (auth)

45007 GROSS THEORY OF NUCLEAR β DECAY. Takahashi, Kohji; Yamada, Masami (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 1470-1503(June 1969).

A theory for the gross properties of the nuclear β-decay is developed. In order to treat the gross features, summations over final states are replaced by integrations, and the average of the squared absolute value of the nuclear matrix element times the final level density (this quantity is denoted by $|M_0(E)|^2$ where $-E$ is the decay energy) is investigated instead of individual matrix elements. First, the general slowness of the allowed β-decay is qualitatively demonstrated by the use of sum rules. Next, a model is set up in order to make quantitative calculations. In this model, an existence of "single-nucleon energies ϵ" is assumed, and each nucleon is assumed to make a "transition" with probability $D_0(E,\epsilon)$ as a result of the operation of the single-particle β-decay operator. $|M_0(E)|^2$ is given as an integral with respect to ϵ, whose integrand is the product of $D_0(E,\epsilon)$ and the distribution function of nucleons over ϵ. Some interference effects are neglected, and the exclusion principle is introduced not in the integrand but in the lower limit of the integration domain. The half-lives of allowed β-decays are calculated with this model. At first, the Fermi gas model is used to evaluate the energy distribution of the single-nucleons. With some trial forms of $D_0(E,\epsilon)$, a reasonable agreement with experiment is obtained for odd-mass nuclei, especially for nuclei with high Q-values. Secondly, the even-odd mass difference is taken into account in a simplified way to refine the treatment of even-mass nuclei. The results show that the majority of allowed β-decays can be explained to a considerable degree by the gross theory which is utterly different from current theories of β-decay. (auth)

45008 DIFFERENCE BETWEEN THE NEUTRON AND PROTON DISTRIBUTIONS IN NUCLEI. Kodama, Takeshi; Yamada, Masami (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto), 41: 1585-6(June 1969).

In a previous paper by Greenlees et al., (Phys. Rev., 171: 1115 (1968)) it was concluded that neutrons are more abundant than protons near the nuclear surface and that the root mean square radius of the neutron distribution is greater than that of the proton distribution. From a study of the Coulomb energy difference between the mirror nuclei, ^{58}Ni and ^{58}Zn, it is shown that the distributions of Greenlees et al. lead to unreasonable results about the β-decay Q value of ^{58}Zn. (B.G.D.)

45009 ANOMALOUS MAGNETIC MOMENT OF THE NUCLEON AND THE MASS DIFFERENCE OF MIRROR NUCLEI. Okamoto, Kazuto (Univ. of New South Wales, Kensington). Progr. Theor. Phys. (Kyoto), 41: 1589-90(June 1969).

Recent studies of the Coulomb energy (E_c) of ^{3}He have shown that E_c is smaller than the binding energy difference (Δ) between ^{3}H and ^{3}He by 10 to 20%. However, the following possibility has been suggested. It is well known that the anomalous magnetic moments (a.m.m.) of the nucleons have large contributions to the n-p mass difference. Indeed, it is so large as to reverse the order of their masses, which is given by an intuitive argument as $M_p > M_n$, to the observed one, $M_n > M_p$. Then there is a possibility that in the case of ^{3}H and ^{3}He also contributions of a.m.m. may be large enough to affect the conclusion that $E_c < \Delta$, because the difference between Δ and E_c is only 10 to 20% of their values. In this note this problem is investigated, and it is shown that inclusion of a.m.m. reduces E_c by 1 to 2%. (auth)

45010 ALPHA CLUSTERING IN NUCLEAR MATTER. Akaishi, Yoshinori; Bando, Hiroharu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 1594-6(June 1969).

It has been previously shown that the binding energy of nuclear matter calculated on the basis of Brueckner theory is now about 5 to 10 MeV per particle according to the adopted nuclear forces compared with the observed value of about 15 MeV. On the other hand variational calculations of ^{3}H and ^{3}He seem to bring about overbinding for the nuclear forces which are favorable to nuclear matter. It is shown that these facts would promote a search for some other origin of energy gain. The α clustering effect in nuclear matter is considered. (B.G.D.)

45011 ON INFLUENCE OF NUCLEON POTENTIAL DEPTH ON DIFFRACTION DISINTEGRATION OF DEUTERONS. Evlanov, M. V. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 890-4(June 1969). (In Russian).

The diffraction interaction of deuterons with nuclei is considered taking into account different values of neutron and proton potentials. Formulas for differential and integral cross sections of diffraction disintegration of deuterons are obtained and the results are discussed. (auth)

45012 NEW NUCLEAR ISOMERS IN THE MICROSECOND REGION. Ivanov, E. A.; Iordachescu, A.; Pascovici, G. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 317-19 (1969).

A preliminary report is presented on short-lived isomers produced using pulsed alpha and proton beams at 24 and 11.2 MeV, respectively. Thick targets of natural elements (or their chemical compounds) were used. The gamma rays emitted were detected by a NaI(Tl) scintillation detector. About 50 elements were irradiated with alpha particles and about 60 elements were irradiated with protons, 9 new isomers being observed. (B.G.D.)

45013 POLARIZATION PHENOMENA IN NUCLEAR REACTIONS: POLARIZATION DYNAMICS. Borsaru, M.; Hategan, C. (Institutul de Fizica Atomica, Bucharest). Stud. Cercet. Fiz., 21: 523-55(1969). (In Rumanian).

Topics discussed are reaction models and polarization, generalized optical model, optical model, DWBA, R matrix theory, and S matrix theory. (auth)

45014 DIRECT INTERACTION WITH CHANNEL COUPLING. II. Hategan, C. (Institutul de Fizica Atomica, Bucharest). Stud. Cercet. Fiz., 21: 557-85(1969). (In Rumanian).

Topics discussed were angular correlations and polarization in SCA, SCA and nuclear models, SCA and the optical model, SCA and DWBA, and SCA and experiences. (auth)

45015 GRAPHIC METHOD OF SOLVING THE DYNAMIC EQUATION DESCRIBING MOVEMENT OF α-PARTICLES IN THE COULOMB FIELD OF THE TERNARY FISSION FRAGMENTS. Romanov, Yu. F.; Konstantinova, G. N. Vestn. Leningrad, Univ., No. 4, Ser. Fiz. Khim., No. 1, 137-44(Feb. 1969). (In Russian).

Graphic method of drawing the charged particle trajectory in the phase space is proposed. The particle moves in the instationary coulomb field of flying away fragments. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

45016 (DOCKET-50003-4) INDIAN POINT STATION, UNIT NO. 1. TECHNICAL SPECIFICATIONS AND BASES. Full-Term Operating License DPR-5. (Consolidated Edison Co. of New York, Inc., New York). Sept. 1969. 93p. Dep. CFSTI.

45017 (DOCKET-50003-5) [INDIAN POINT NUCLEAR GENERATING UNIT 1]. DESIGN REPORT: ECC SYSTEM REACTOR HEAD MODIFICATIONS. (Consolidated Edison Co. of New York, Inc., New York). Sept. 5, 1969. 15p. Dep. CFSTI.

Modifications to the Indian Point Power Reactor, Unit 1 vessel head are described. ECCS piping and penetrations are described; design parameters are given. ECCS temperature parameters are tabulated for accident and normal operation conditions. (M.L.S.)

45018 (DOCKET-50016-24) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. SITE GEOLOGY AND SEISMOLOGY. (Power Reactor Development Co., Detroit, Mich.). Sept. 3, 1969. 72p. Dep. CFSTI.

Geologic studies performed for the Fermi Power Reactor, Unit 2 are described. Results of these studies for evaluating site suitability are presented. 44 references. (auth)

45019 (DOCKET-50133-17) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Preliminary Hazards Summary Report, Exhibit B. (Pacific Gas and Electric Co., San Francisco, Calif.). Apr. 15, 1959. 542p. Dep. CFSTI.

HUMBOLDT BAY POWER REACTOR —site for preliminary safety analysis of
—core for, preliminary safety analysis of design for
—cooling system for, preliminary safety analysis of design for
—containment system for, preliminary safety analysis of
—control systems and instrumentation for, preliminary safety analysis of
—emergency and auxiliary systems for, preliminary safety analysis of
—electrical systems for, preliminary safety analysis of
—radwaste system for, preliminary safety analysis of
—steam and power conversion system for, preliminary safety analysis of
—safety analyses for, preliminary (M.L.S.)

45020 (DOCKET-50171-9) PEACH BOTTOM ATOMIC POWER STATION. Monthly Operations Report No. 38, April 1969. (Philadelphia Electric Co., Pa.). 15p. Dep. CFSTI.

45021 (DOCKET-50171-10) PEACH BOTTOM ATOMIC POWER STATION, UNIT NO. 1. Monthly Operations Report No. 41, July 1969. (Philadelphia Electric Co., Pa.). Sept. 8, 1969. 13p. Dep. CFSTI.

45022 (DOCKET-50213-17) REPORT OF CONTROL ROD MALFUNCTION. (Connecticut Yankee Atomic Power Co., Boston, Mass.). Aug. 31, 1969. 2p. Dep. CFSTI.

The report of the sticking of control rod No. 43 during approach-to-critical in the Connecticut Yankee Power Reactor is detailed. Efforts to free the stuck rod and results of these efforts are described. (M.L.S.)

45023 (DOCKET-50237-14) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Supplementary Information, Amendment 19 for Unit 2 and Amendment 20 for Unit 3. (Commonwealth Edison Co., Chicago, Ill.). Sept. 2, 1969. 207p. (DOCKET-50249-15). Dep. CFSTI.

Details of the rod block monitor (RBM) design and operation in Dresden Power Reactor, Units 2 and 3, are given. Effects of possible RBM failures are evaluated. A dynamic analysis of the piping system is detailed; effects of seismic loadings are detailed. Maximum stresses are tabulated. Proposed technical specifications and bases are included. (M.L.S.)

45024 (HPR-110) OBSERVATIONS OF FUEL PIN INTERNAL PRESSURE. Hurme, M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). June 1969. 37p. Dep.

In-pile measurements of fuel pin gas pressure are performed in Halden with a diaphragm-type pressure transducer. When the moderator is electrically heated from 80°C to 160°C, pressure peaks around 100°C have been observed in some newly loaded fuel assemblies, indicating moisture release. During the nuclear heating of the moderator from 160°C to 240°C a pressure increase has been observed which is significantly larger than that corresponding to the thermal expansion of the filler gas. After the first heating-up of the assembly, the pressure can decrease even at constant power level, indicating decomposition of water from moisture in the fuel. This process takes from some hours to two weeks. Power cycling accelerates both the water decomposition process and the gas release. When fuel is brought from full power to zero and up to full power again, no sudden increase of pressure or gas release has been observed. The pressure at full power is higher than before the power cycle only in those assemblies which already had some fission gas released. If the fuel temperature at normal operating conditions is below 1650°C, very small gas releases can be detected. The temperature in the fuel governs the release of fission gases. Thus the assembly power level history has strong influence on pressure build-up, as demonstrated by comparing the measured pressures in similar assemblies at different operated power levels. The observed release rates are equal to or smaller than those based on the two stage release model (100% release above 1650°C, 4% release below 1650°C). (auth)

45025 OPERATIONAL BEHAVIOUR OF NUCLEAR STATIONS WITH HELIUM TURBINE. Kueper, K. D. Energ. Tech., 20: 275-8(Sept. 1968). (In German).

The 25 MW(e) station in Geesthacht-Tesperhude contains a He cooled reactor from which the highly heated He is passed directly to the turbine. The operational behavior and controls are considered. These deal with the He-turbine circuit, reactor, behavior of the plant during startup, shutdown and sudden loss of load. (auth)

45026 HOW SAFE ARE NUCLEAR POWER STATIONS. Franzen, F. Tech. Ueberwach., 9: 397-9(Dec. 1968). (In German).

The use of the m.c.a. in safety analyses of nuclear power plants is described. A comparison of 2×10^{-6} fatalities/MW per year as the probability of the m.c.a. is made with the 3×10^{-3} fatalities/MW per year resulting from air pollution by thermal stations. Safety criteria are listed for deciding how safe nuclear power plants are. The problems are indicated on which study must be concentrated if the present unsatisfactory position regarding the safety analysis of nuclear plants must be improved. (UKAEA Info. Bull.)

45027 SAINT-LAURENT-DES-EAUX I NUCLEAR POWER STATION. Leterrier, G. Energ. Nucl. (Paris), 11: 268-75 (July 1969). (In French).

On the occasion of the commissioning of St-Laurent-des-Eaux I, the concepts which directed the choice of the reactor's characteristics, the main technical problems encountered, and the special methods selected for its construction are discussed. Since the generators were coupled, the power station has delivered 160 GWh in two months. (auth)

45028 HIGH TEMPERATURE GAS COOLED REACTOR: PROGRESS IN NUCLEAR POWER GENERATION. Stevenson, F. F. (HPAC, Wynnewood, Pa.). Heat., Piping Air Cond., 40: No. 8, 95-9(Aug. 1968).

Design parameters and operational performance of the Peach Bottom Power Reactor Unit 1 are reviewed. (auth)

45029 INSTRUMENTATION IN THE POWER INDUSTRY. VOLUME 11. Proceedings of the Eleventh International ISA Power Instrumentation Symposium May 13-15, 1968, Chicago, Illinois. Gardner, C. H. (ed.). ISA (Instrum. Soc. Amer.), Proc., Int. Power Instrum. Symp., 11: 1-146(1968). (CONF-680551).

Topics discussed include power reactor personnel training, equipment, and control systems. Separate abstracts are included for 2 of the 13 papers presented. (D.C.C.)

For abstracts of individual papers see: 45062 and 45150.

45030 RINGHALS NUCLEAR POWER STATION. Molin, Ake (AB ASEA-ATOM, Vaesteras, Sweden). ASEA's (Allmanna sv. Elek. A. B.) Tidn., 61: 43-7(1969). (In Swedish).

A description is made of the Ringhals Nuclear Power Station. The station is to be situated at the Swedish west coast, 33 miles south of Gothenburg. It will consist of four units with a total electrical effect of 3,000 MW. The first unit will have an effect of 750 MW and be in operation in June 1973. (Sweden)

45031 THE NUCLEAR REACTOR FOR UNIT 1 OF THE RINGHALS POWER STATION. Sundqvist, Cnut (AB ASEA-ATOM, Vaesteras, Sweden). ASEA's (Allmanna sv. Elek. A. B.) Tidn., 61: 48-53(1969). (In Swedish).

A description is made of the reactor, the control, and the ser-

vice systems, for the 1st unit of the Ringhals Power Station south of Gothenburg. Principal data are given. (Sweden)

45032 THE FIRST FUEL CHARGE FOR THE OSKARSHAMN POWER STATION. Brandberg, Sven; Widell, Bjoern (AB ASEA-ATOM, Vaesteras, Sweden). ASEA's (Allmanna sv. Elek. A. B.) Tidn., 61: 54-8(1969). (In Swedish).

A description is made of the 1st fuel inventory for unit 1 of the Oskarshamn Nuclear Power Station. Principal data are given. The changing system, fabrication and testing are reviewed. (Sweden)

45033 ACQUIRING AND OPERATING A NUCLEAR POWER PLANT. Webster, William. EEI (Edison Elec. Inst.) Bull., 37: 106-9(Apr. 1969).

The Yankee group consists of 12 small and medium size utilities banded together for construction and operation of a full-sized nuclear plant in New England. Since 1954 there have been 8 projects: Massachusetts Yankee with more than 7 yr commercial operation and more KWh generated than any other nuclear plant; Connecticut Yankee, largest privately owned plant in service, in commercial operation since Jan. 1, 1968, operating at full licensed power of 490 MW electric; Vermont Yankee, 540 MW, BWR, river location, 1971 completion; Maine Yankee, 850 MW, PWR, Atlantic estuary, 1972 completion; and 4 projects, nuclear plants in the 600- to 900-MW range, 2 of them PWR and 2 BWR, with completion dates from 1970 to 1974. Observations and suggestions for a utility company with little or no nuclear background to plan, arrange, and organize to carry out an entry into the business of adding a nuclear plant to its energy supply system are made. (BBB)

45034 ELECTRICITY PRODUCTION UNIT. Blot, R.; Langlois, G. Bull. Inform. Sci. Tech. (Paris), No. 138, 65-74(June 1969). (In French).

The water-steam circuit installed for electricity production at the nuclear power station Phenix is described. The steam produced by the steam generator is used in a 250 MW(e) turbo-alternator identical with those of existing French thermal power stations. (auth)

45035 PROBLEMS INVOLVED IN THE CONSTRUCTION OF THE PROTOTYPE POWER STATION PHENIX. Carle, R.; Moreau, J. C.; Megy, J. Bull. Inform. Sci. Tech. (Paris), No. 138, 5-8 June 1969). (In French).

The chief problems arising in the construction of the prototype fast-neutron power station Phenix are reviewed. The special organization of the scientific team in charge of the project is described. (auth)

45036 THE OPTIONS TAKEN FOR PHENIX AND THEIR RELATIONSHIP WITH TECHNOLOGICAL TESTS. Rozenholc, M. Bull. Inform. Sci. Tech. (Paris), No. 138, 9-16(June 1969). (In French).

The solutions adopted for Phenix and the technological tests necessary as a result are presented in increasing order of innovation, from conventional power station assemblies to equipment based on new techniques. Various components of the station are described in turn, their design being influenced by one of the dominant features characterising Phenix: prototype station; sodium-cooled; and fast neutron. (auth)

45037 THE POWER STATION PHENIX: OVERALL DESCRIPTION, OPERATION, AND SPECIFICATIONS. Crette, J. P.; Quagliotti, C. Bull. Inform. Sci. Tech. (Paris), No. 138, 17-32 (June 1969). (In French).

The French fast reactor prototype Phenix is a 250 MW (electr.) nuclear power station. The design of the sodium cooled reactor is of the "pot" type: core, pumps, intermediate heat exchangers are located in the same vessel. The three independent secondary loops are connected to three steam generators, which produce steam for a conventional turbo-generator set. The main characteristics of the plant are given. (auth)

45038 PHENIX REACTOR BLOCK. Langrange, M.; Maurel, J.; Cayol, A.; Clottes, G.; Ratier, J. L. Bull. Inform. Sci. Tech. (Paris), No. 138, 33-48(June 1969). (In French).

The following systems of the Phenix Fast Reactor are described: the inner shielding; the support for the fuel elements; the confinement and safety tanks; the system for suspending the whole set-up to an upper metal framework known as the slab; the primary pumps; and the various measuring systems provided to allow power control and guarantee safety, or to enable structural changes to be observed during the lifetime of the reactor. A description of the fuel elements as compared with those of Rapsodie is presented. (auth)

45039 HEAT TRANSFER CIRCUITS FROM PRESSURE-VESSEL TO TURBO-ALTERNATOR ROOM. Befre, J. L.; Greffier, P.; Vercasson, M. Bull. Inform. Sci. Tech. (Paris), No. 138, 49-64(June 1969) . (In French).

The function of the secondary circuit, Na, is to transfer this energy from pressure vessel, by the means of intermediary heat exchangers, to steam-circuits which are connected to the turbine. A description of this secondary circuit is presented. The steam generator, with its risks of Na-water reactions in case of leaks, is the most critical item of the chain. (auth)

45040 THE HANDLING OF FUEL AND SPECIAL HANDLING OPERATIONS. Boulinier, C. Bull. Inform. Sci. Tech. (Paris), No. 138, 75-98(June 1969). (In French).

The handling systems for control rods, guide tubes, fuel and shielding assemblies, include: the preparation of new elements; transfer into the reactor; reactor loading and unloading; outside storage in drums; conditioning of irradiated elements in hot cells; and transfer to the processing plant or to an effluent storage point. The systems for handling the primary pumps and exchangers, the control rod mechanisms, the transfer arm and other irradiation devices include: special exhaust hoods; storage and washing decontamination tanks; and the dismantling cell. (auth)

45041 CONTROL SYSTEM AND ELECTROTECHNOLOGY. Chapelot, A. Bull. Inform. Sci. Tech. (Paris), No. 138, 99-104(June 1969). (In French).

The matter of control systems is described. Principal electric supply main features of the power station actuators are specified. (auth)

45042 SAFETY PROBLEMS. Lichtenberger, F.; Petit, J. Bull. Inform. Sci. Tech. (Paris), No. 138, 105-12(June 1969). (In French).

The safety problems of Phénix only differ from those of the other reactor streams by the presence of a large mass of Pu, the specific power, the use of Na as cooling fluid and the existence of an active Ar loop. While the specifications of the reactor are such that it is relatively easy to avoid primary reactivity accidents, the very high specific power leads to the special danger of cooling system accidents. Many steps are taken to guarantee the continuity of the core cooling. Particular attention will be paid to the tightness of the Na and Ar loops. A large-scale test program is centered on the water–Na reaction in the steam generators. (auth)

45043 CIVIL ENGINEERING AND PRELIMINARY WORK. Labat, P.; Dufournet, C.; Cregut, A. Bull. Inform. Sci. Tech. (Paris), No. 138, 113-16(June 1969). (In French).

The main buildings lay out and the data of the ground are presented. The buildings' general characteristics are described. (auth)

45044 SETTING UP OF THE PHENIX CONSTRUCTION PROGRAM. Guillemard, B.; Sachnine, Ph. Bull. Inform. Sci. Tech. (Paris), No. 138, 117-26(June 1969). (In French).

The program of data processing by computer is briefly described. The various phases of the setting up of Phenix planning are presented. (auth)

Power Reactor Development

45045 (AECL-3293) ENERGY CONSUMPTION: ITS GROWTH AND PATTERN. Merlin, H. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Mar. 1969. 29p. (CONF-690412-2). Dep. CFSTI (U.S. Sales Only). CAN $1.00.

From 71st Annual General Meeting of the Canadian Institute of Mining and Metallurgy, Montreal, Canada.

The past demands for energy and the contributions by the major sources are shown for the world and regions, and Canada. Three forecasts of future demands are presented. By the year 2000, the world will be consuming energy at a rate of $670-700 \times 10^{15}$ Btu/year. Canada's rate is estimated at 20×10^{15}. Electricity will increase its portion of energy from 7.5% to 15% and over 40% of the primary energy will be required to generate it. World, regional and Canadian forecasts are given for total electricity generated and for electricity generated in nuclear stations. The integral world requirement for energy by the year 2000 will be over 12×10^{18} Btu. Current recoverable fossil and hydro reserves are about 18×10^{18} Btu. The total reserves are estimated to be seven times greater. World production of electricity in nuclear stations by the year 2000 will be almost three times the electricity produced in the world today. The amount of fuel consumed in generating this electricity will depend upon the types and mix of reactors installed. The heavy water reactors alone

or in conjunction with fast breeders and liquid fuel reactors are the most efficient users of U and Th resources. The heavy water reactors are also the most efficient producers of Pu which will be required as fuel for fast breeders. 18 references. (auth)

45046 (ANL-7581) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JUNE 1969. (Argonne National Lab., Ill.). July 29, 1969. Contract W-31-109-eng-38. 136p. Dep. CFSTI.

Highlights of project activities are summarized for the month of June 1969. Fuel and components development programs for the LMFBR are described. LMFBR physics measurements and ZPR-3, ZPR-6, ZPR-9, and ZPPR operations during June are reviewed. Research and development programs in the EBR-2 are described. Nuclear safety studies, including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

45047 (ANL-7595) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, JULY 1969. (Argonne National Lab., Ill.). Aug. 25, 1969. Contract W-31-109-eng-38. 127p. Dep. CFSTI.

Highlights of project activities are summarized for the month of July 1969. Fuel and components development programs for the LMFBR are described. LMFBR physics measurements and ZPR-3 and ZPPR operations during July are reviewed. Research and development programs in the EBR-2 are described. Nuclear safety studies; including TREAT operations, and chemical separation activities are discussed. (D.C.C.)

45048 (CEND-337(Vol. 1)) 1000 Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY: REPORT OF TASKS II AND III. A REFERENCE CONCEPTUAL DESIGN OF A 1000 Mwe LMFBR. VOLUME I. CONCEPTUAL SYSTEM DESIGN DESCRIPTIONS. (Combustion Engineering, Inc., Windsor, Conn.). [July 1968]. Contract 31-109-38-1999. 105p. Dep. CFSTI.

For Argonne National Lab., Ill.

Design information related to a reference 1000 MW(e) liquid Na-cooled fast breeder reactor is presented. Topics discussed include: reactor core system; reactivity control system; reactor vessel system; reactor support systems; and safety systems. (D.C.C.)

45049 (CEND-337(Vol.2)) 1000 Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY: REPORT OF TASKS II AND III. A REFERENCE CONCEPTUAL DESIGN OF A 1000 Mwe LMFBR. VOLUME II. STATIC DESIGN AND PERFORMANCE ANALYSES. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). [1967]. Contract 31-109-38-1999. 121p. Dep. CFSTI.

For Argonne National Lab., Ill.

Design information related to a reference 1000 MW(e) liquid Na-cooled fast breeder reactor is presented. Topics discussed include: reactor core system; reactor vessel system; and reference refueling conceptual design. 19 references. (D.C.C.)

45050 (CEND-346) 1000 Mwe LIQUID METAL FAST BREEDER REACTOR FOLLOW-ON STUDY: TASK IV REPORT. A RESEARCH AND DEVELOPMENT PROGRAM NEEDED FOR THE C-E REFERENCE CONCEPT. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Feb. 1969. Contract 31-109-38-1999. 200p. Dep. CFSTI.

For Argonne National Lab., Ill.

Design information related to a reference 1000 MW(e) liquid Na-cooled fast breeder reactor is presented. Topics discussed include: plant design; fuels and materials; safety; core design; components; and physics. 12 references. (D.C.C.)

45051 (CONF-681064-2) COMPONENTS FOR NUCLEAR POWER STATIONS. PART A. REACTOR COMPONENTS. PART B. COMPONENTS FOR SODIUM COOLED REACTORS. Duncton, P. J. (Part A) (Fairey Engineering Ltd., Heston (England)); Cundill, B. (Part B) (English Electric Co., Ltd., Whetstone (England)). [1968]. 9p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

In Part A the general principles in the design and construction of components for gas cooled reactors and the SGHWR are discussed. The design, development, and testing of pumps, valves, heat exchangers, and sodium instrumentation are discussed in Part B. (UK)

45052 (GA-9090) HTGR BASE PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING NOVEMBER 30, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 30, 1968. Contract AT(04-3)-167. 63p. Dep. CFSTI.

GRAPHITE — radiation effects on dimensional changes in, measurement of fast neutron
NEUTRONS, FAST — effects on thermal conductivity of silicon carbide
— effects on physical properties of BISO HTI and BISO LTI coated particle type uranium carbide (UC_2)
— effects on dimensional changes in graphite
REACTOR CONTROL ELEMENTS — reactivity worth of high temperature gas cooled reactor, (E/T)
REACTOR FUELS — reprocessing method for high temperature gas cooled power reactor, analysis of optimum economic
REACTORS, GAS-COOLED — fuel recycle for high temperature power, analysis of optimum economic
— design parameters for conceptual high temperature power, development during September to November 1968
REACTORS, POWER — fuel recycle for high temperature gas cooled, analysis of optimum economic
— design parameters for conceptual high temperature gas cooled, development during September to November 1968
SILICON CARBIDES — effects on oxidation stability of thorium carbide (ThC_2)–uranium carbide (UC_2) particle fuel of coatings of
— radiation effects on thermal conductivity of, measurement of fast neutron
THORIUM CARBIDES — ThC_2–UC_2, stability of silicon carbide (SiC) coated particle type, effects of coating thickness on oxidation
URANIUM CARBIDES — ThC_2–UC_2, stability of silicon carbide (SiC) coated particle type, effects of coating thickness on oxidation
— radiation effects on physical properties of BISO HTI and BISO LTI coated, measurement of fast neutron (D.C.C.)

45053 (GA-9372) HTGR BASE PROGRAM REPORT FOR THE PERIOD ENDING MAY 30, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). June 27, 1969. Contract AT(04-3)-167. 292p. Dep. CFSTI.

BLOWERS — design criteria for reheat steam driven, for conceptual 1000 MW(e) HTGR
FISSION PRODUCTS — behavior in HTGR systems
— sorption by graphite
— diffusion in graphite
GRAPHITE — fission product diffusion in
— sorptive properties for fission products
— radiation effects on swelling in, fast neutrons
HEAT TRANSFER SYSTEMS — flow diagram for conceptual 1000 MW(e) HTGR
NEUTRONS, FAST — effects on swelling in graphite
REACTOR CONTAINMENT STRUCTURES — design parameters for conceptual 1000 MW(e) HTGR
REACTOR CONTROL ELEMENTS — reactivity worth of conceptual 1000 MW(e) HTGR
REACTOR FUELS — reprocessing methods for HTGR type
— cycle management for conceptual 1000 MW(e) HTGR
REACTOR LOADING MACHINES — development of conceptual 1000 MW(e) HTGR
REACTORS, GAS-COOLED — design parameters for conceptual 1000 MW(e) HTGR, development during March to May 1969 of
— remote handling and viewing equipment for conceptual 1000 MW(e) HTGR, development of
— loading machine for conceptual 1000 MW(e) HTGR development of
— blower for conceptual 1000 MW(e) HTGR concept, design criteria for reheat steam driven helium
— cooling system for conceptual 1000 MW(e) HTGR, flow diagrams of
— containment structures of conceptual 1000 MW(e) HTGR, design parameters for
REMOTE-HANDLING EQUIPMENT — development of conceptual 1000 MW(e) HTGR
REMOTE-VIEWING EQUIPMENT — development of conceptual 1000 MW(e) HTGR (D.C.C.)

45054 (GEAP-5710) METHODS, SYSTEM OPTIMIZATION, AND SAFETY STUDIES FOR A 1000 MWe SODIUM-COOLED FAST REACTOR. Task III and V Report of 1000 MWe LMFBR Follow-on Work. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Feb. 1969. Contract 31-109-38-1997. 484p. Dep. CFSTI.

For Argonne National Lab., Ill.

Major objectives of the LMFBR follow-on work are to provide a relative comparison of the cost incentives for various design alternatives and to weigh the cost incentives against the development required to achieve the state of technology implied. Another objective is to provide a reference design with sufficient detail to permit a definition of absolute costs. The results of trade-off and optimization studies in which numerous design parameters and economic ground-rules are varied to determine the effect on the economics of the reference concept are presented. Safety

studies related to the reference design are included. 70 references. (H.D.R.)

45055 NUCLEAR POWER STATIONS FOR THE SUPPLY OF POWER AND HEAT TO INDUSTRY. Schuller, K. H. BBC-Nachr., 50: 651-6(Nov. 1968). (In German).

Proposals are made for nuclear power stations designed to carry out simultaneously power generation for public supply and generation and process steam supply to industry. The conditions for economic viability are that the installations should be of sufficient size (several hundreds of MVA of generation), that efficient pass-out operation should be secured by using a high-temperature gas-cooled reactor and that the oil- or gas-fired reserve stand-by boilers should be used for normal peak-load lopping. (UKAEA Info. Bull.)

45056 NUCLEAR REACTOR PROVIDED WITH THERMIONIC CONVERTERS. (to Brown, Boveri and Cie, AG). British Patent 1,160,469. Aug. 6, 1969. Priority date May 13, 1966, Germany.

REACTORS, POWER—thermionic converters in core of description of heat pipe cooled hermetically sealed coaxal
THERMIONIC CONVERTERS—use for power conversion of heat pipe cooled hermetically sealed coaxial, in power reactors (D.C.C.)

45057 BOTTOM FUELLED REACTOR. (to Canadian General Electric Co., Ltd.). British Patent 1,161,515. Aug. 13, 1969. Priority date Nov. 20, 1965, Canada.

REACTORS, HEAVY WATER-MODERATED—design parameters for downward coolant flow underneath core loaded pressure tube type (D.C.C.)

45058 OFFICIAL INAUGURATION OF THE BR3/VULCAIN REACTOR. Bull. Belgicatom, 12: 24(1967).

The BR3/Vulcain reactor was officially inaugurated on 27 June, 1967 at Mol, Belgium. Since 1966, electricity of nuclear origin has been regularly supplied to the national grid by a reactor core of Belgian concept. In December 1966 the Vulcain reactor reached its full power at the alternator terminals. Since then, full power has been supplied on a practically continuous base. The modifications carried out on the BR3 reactor at Mol to accommodate a Vulcain core meet the objectives of the Vulcain program: to provide to industry and laboratories the opportunity to gain the know-how required in the nuclear field; and to develop a reactor specially designed to be economically attractive in the range of small or intermediate power and consequently able to provide new channels in foreign trade. (BBB)

Kinetics and Dynamics

45059 (AI-CE-Memo-69) HEAVY WATER ORGANIC COOLED REACTOR. HWOCR-SAFE: A MONTE CARLO REACTOR ANALYSIS CODE. Levitt, L. B.; Lewis, R. C. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc. [Windsor, Conn.]). June 30, 1967. Contract AT(38-1)-430. 131p. Dep. CFSTI.

HWOCR-SAFE is a Monte Carlo reactor analysis code capable of completely describing proposed HWOCR lattice configurations as well as more approximate annular representations of them. It is designed to be used as a bench mark tool to check multigroup diffusion and transport calculations and to evaluate the effect of the geometric approximations necessary in such calculations. Cross section data may be treated in great detail in the thermal and epithermal energy ranges so that multigroup constants can also be checked. HWOCR-SAFE is an outgrowth of the SAFE code which was designed to evaluate the criticality of three dimensional fuel assemblies for nuclear safety studies. Versions of HWOCR-SAFE are available in FORTRAN IV for the IBM 7094 and in FORTRAN H for the IBM system 360. (auth)

45060 (GA-9482) DEVELOPMENT OF THE FLOW ANALYSIS CODE FLAC. Malek, G. J. (Gulf General Atomic, Inc., San Diego, Calif.). June 1969. Contract AT(04-3)-167. 38p. Dep. CFSTI.

A flow analysis code, FLAC, was developed to perform flow distribution and thermal performance analyses on advanced HTGR reactors. The computer program is capable of analyzing flow distributions in arbitrary flow networks with heat addition. The program is written in FORTRAN S for the UNIVAC 1108 computer. 4 references. (auth)

45061 PHYSICS STUDIES ON BWR VOID SIMULATED CORES. I. Kikuchi, Hiroshi; Fujii, Masaaki; Kiyokawa, Kazuhiro; Ohnishi, Tadahiro; Kobayashi, Setsuo (Hitachi Ltd., Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 458-65(Aug. 1969).

In an attempt to obtain more information concerning steam void effects on the physical behavior of BWR cores, voids ranging from zero to 24% volume fractions were statically simulated by inserting polyethylene tubes between fuel rods of simulated BWR core, and measurements were made of local flux distribution, neutron spectrum, reactivity, reactivity coefficient of void and so forth. The results were compared with calculations. Improved methods of calculation were developed, which assured better agreement with measured results. Although only local distributions of the thermal neutron flux and spectrum within the assembly cells are analyzed, it has been shown that spectrum variation near water gaps could be well described by an overlapping model which provided an improvement on the analysis. An additional improvement was obtained by the incorporation of an approximate transport correction. 5 references. (auth)

Control Systems

45062 APPLICATION OF CONTROL SYSTEMS FOR PRESSURIZED WATER REACTORS. Garber, Irwin (Westinghouse Electric Corp., Pittsburgh). ISA (Instrum. Soc. Amer.), Proc., Int. Power Instrum. Symp., 11: 98-115(1968).

From 11th International Power Instrumentation Symposium, Chicago, Ill. See CONF-680551.

The PWR Control Systems are designed to respond safely and accurately under steady-state and transient conditions with a minimum of undesired interactions between process controlled variables. Control theory, mathematical modeling, extensive testing programs and past applications of control system techniques are used by the control system design engineers to acquire knowledge of the dynamic behavior of the PWR plant processes and to advance their control system concepts. The major systems of the PWR plant, measurements used in the reactor control systems and the present application of the PWR control systems are described. 7 references. (auth)

Shielding

45063 (JPRS-48590) PROBLEMS OF THERMAL AND RADIATION SHIELDING OF A REACTOR VESSEL. Broder, D. L.; Popkov, K. K.; Suvorov, A. P. Translated from At. Energ. (USSR), 26: 260-9(1969). 16p. CFSTI.

In NSA, 23: 23886.

A survey of reducing the radiation heat release and damage of the reactor vessel material is given. Separate components of heat release and the results of the investigation of the thermal shielding composition influence on the vessel radiation heating are considered. Some ways of reducing the heat release are presented. The radiation damage effects of the steel reactor vessel are analyzed. Various models of simple and complex defect formations in irradiated materials are described. A study has been made of the energy dependence of the radiation neutron efficiency and its influence on the integral radiation. The results of the optimization of vessel radiation shielding are given. The reactor vessel useful life is estimated. 33 references. (auth)

45064 NUCLEAR REACTOR SHIELD STRUCTURE. Brown, W. M.; Adams, E. J.; Blackburn, R. W. (to Canadian General Electric Co., Ltd.). Canadian Patent 816,349. June 24, 1969.

An improved arrangement is described for CANDU-type reactors in which the dump tank is made integral with the calandria so that a smaller vault is required thus lowering the capital costs. Adequate thermal and biological shielding is provided together with means to allow for added thermal stresses because calandria and dump tank may be regarded as a single unit. A non-rigid plate with apertures for fuel rods and coolant tubes is a new feature of the design. (F.S.A.)

45065 NUCLEAR REACTOR SUPPORT STRUCTURE AND END SHIELDS. MacKay, I. N. (to Canadian General Electric Co., Ltd.). Canadian Patent 816,350. June 24, 1969.

A girder support structure for use with a fluid cooled heavy water moderated vertically tubed nuclear reactor is described. It consists of a combined support structure and radiation shield for a reactor having tubes extending vertically therefrom, and comprises horizontally extending upper and lower structural and shielding flange members having aperatures in vertical alignment to receive the tubes. There are several web members secured to the flange members and extending vertically between them, also horizontally extending bearer members. The shield members extend between adjacent pairs of parallel web members and are also parallel with the upper and lower flange members. Aperatures are suitably placed so that the reactor tubes

can extend vertically therethrough. The object of such structure is to minimize thermal expansion movement. (F.S.A.)

Cooling Systems

45066 (DOCKET-50016-22) AN EVALUATION OF THE POSSIBILITIES THAT CORROSION CAN CAUSE RAPID SIMULTANEOUS FAILURES IN PRIMARY PIPING AND CONTAINMENT IN THE ENRICO FERMI REACTOR. (Battelle Memorial Inst., Columbus, Ohio). June 13, 1969. 14p. (BMI-APDA-69-1). Dep. CFSTI.

For Atomic Power Development Associates, Inc., Detroit, Mich.

The possible conditions which could lead to rapid corrosion attack and simultaneous double ended rupture of the primary and containment piping in the Fermi Fast Breeder Reactor have been reviewed and evaluated. No credible combination of conditions could be found which would lead to such a failure. Potentially the worst condition would be a Na leak through the primary piping in the below-floor area when moisture and oxygen content of the atmosphere were high, and the resulting reaction products would attack both the primary and secondary piping. For such a condition to cause rapid failure the Na leak would have to be so small that it would not be detected but would spread over a narrow band around the complete circumference of the pipe. In addition, the reaction products would have to attack the pipe at a uniform rate to cause a rupture failure rather than a leak. Failure by the above mechanism does not seem probable since an undetected Na leak and the other combination of circumstances are unlikely. Other possibilities studied were Na corrosion, caustic attack, caustic cracking, chloride stress corrosion, dry salt attack, nitric acid attack, polythionic acid cracking, and hydrogen sulfide cracking. 17 references. (auth)

45067 (DOCKET-50016-23) STRUCTURAL DESIGN REVIEW OF THE ENRICO FERMI ATOMIC POWER PLANT PRIMARY COOLANT SYSTEM. (NUS Corp., Rockville, Md.). July 1969. 124p. (NUS-578). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

A detailed design review of the primary system components for the Fermi Fast Breeder Reactor is presented. The review was performed to determine that no other components in the primary system could become detached and relocated in such a way as to retard flow to the subassemblies. 13 references. (auth)

45068 (GA-8439(Rev.)) REACTOR ARRANGEMENT STUDIES FOR A LARGE HTGR PLANT. Morse, D. C.; Wiard, H. K. (Gulf General Atomic, Inc., San Diego, Calif.). July 31, 1969. Contract AT(04-3)-167. 44p. Dep. CFSTI.

A study is presented of possible arrangements of the reactor core and primary coolant system components within a single prestressed concrete reactor vessel for a 1000-MW(e) high-temperature gas-cooled reactor (HTGR) plant. Although the study deals primarily with the configuration of the prestressed concrete reactor vessel (PCRV) that houses the reactor and the primary coolant system, related questions concerning the number and size of primary system components are also considered. Alternative arrangements are evaluated on the basis of capital cost, operating cost, plant reliability and maintainability, inherent safety features, research and development requirements, and flexibility in accommodating changes in component design and plant size. An arrangement based on the multicavity type of PCRV is recommended as the single vessel, integral-containment arrangement to be used in further work on the 1000-MW(e) plant. In this arrangement, the primary coolant system is composed of six parallel loops, each loop containing one steam generator and one He circulator. The reactor core is contained in a central cavity of the PCRV, while the steam generators and circulators are located in six smaller cavities in the side wall of the PCRV. 2 references. (auth)

45069 (GEAP-5770) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 15, October–December 1968. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1969. Contract AT(04-3)-189. 126p. Dep. CFSTI.

CHROMIUM ALLOYS AND SYSTEMS—Cr–Mo–steel, crack growth in, effects of temperature and stress on low cycle fatigue
MOLYBDENUM ALLOYS AND SYSTEMS—Cr–Mo–steel, crack growth in, effects of temperature and stress on low cycle fatigue
PIPES—crack growth in metal, equations for through wall low cycle fatigue
—stress analysis in metal, computer program for
—crack growth in ASTM A-106B steel seamless, effects of flow configurations on
STAINLESS STEEL—crack growth in Type 304, effects of temperature and stress on low cycle fatigue
STEEL—crack growth in seamless pipes of ASTM A-106B, effects of flow configurations on
STEEL—Cr–Mo–steel, crack growth in, effects of temperature and stress on low cycle fatigue (D.C.C.)

45070 (ORNL-TM-2643) CONCEPTUAL SYSTEM DESIGN DESCRIPTION OF THE SALT PUMP TEST STAND FOR THE MOLTEN SALT BREEDER EXPERIMENT. Grindell, A. G.; McGlothlan, C. K. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 53p. Dep. CFSTI.

A stand is required to test the salt pumps for the Molten Salt Breeder Experiment (MSBE). It will be designed to accommodate pumps having capacities ranging from 3000 to 7000 gpm and operating with salt of specific gravities to 3.5 at discharge pressures to 400 psig and temperatures to 1300°F normally and to 1400°F for short periods of time. Both the drive motor electrical supply and the heat removal system for the loop will be designed for 1500 hp. Preventive measures to protect personnel and equipment from the deleterious effects of a salt leak will be taken. The primary and secondary salt pumps for the MSBE will be operated in the stand using a depleted U, natural LiF salt to simulate the MSBE primary salt. A prototype salt pump, procured from the U. S. pump industry, will be subjected at representative operating conditions to performance and endurance testing of its hydraulic, mechanical, and electrical design features. The MSBE salt pump rotary elements will be subjected to hot shakedown testing in the stand to provide final confirmation of performance prior to installation in the reactor system. The Xe-removal device and molten salt instrumentation to measure pressure, flow, liquid level, etc. will be tested at design conditions in molten salt as they become available, and the stand will be modified, as required, to accommodate these tests. The conceptual design of the test stand is presented. The description, function, and design requirements for components and subsystems are provided. The principles of operation of the test stand and the safety precautions are discussed. The maintenance philosophy is described and the quality assurance program is outlined. (auth)

45071 (WCAP-7015(Rev.1)) SUBCHANNEL THERMAL ANALYSIS OF ROD BUNDLE CORE. Chelemer, H.; Weisman, J.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967; Revised Jan. 1969. 44p.

The subchannel analysis presented substantially revises the concept of engineering hot channel factors. Previous design techniques sequentially applied hot channel factors to the core average enthalpy rise and flow in an attempt to estimate the flow and enthalpy rise in the hottest subchannel of the core. In the method described, a three-dimensional matrix is used to represent the core. Coolant conditions within each matrix element are determined by simultaneous solution of the equations of conservation of mass, energy, and momentum. The behavior of the hot assembly is determined by superimposing the power distribution among the assemblies upon the flow distribution while allowing for flow mixing between assemblies. The core-wide assembly-by-assembly analysis computes the flows to and from the hot assembly. A new three-dimensional matrix is then used to represent the subchannels within this assembly. Coolant conditions are obtained from solution of the continuity equations for each matrix element using the flows to the hot assembly as a boundary condition. The local variations in power, fuel rod and pellet dimensions, and mixing within the assembly, are superimposed in these calculations in order to determine the conditions in the hot subchannel. The simultaneous consideration of all variations from nominal conditions provides a realistic evaluation of hot channel behavior. The procedure avoids the repetitive application of penalty factors inherent in the use of the simple product of all hot channel subfactors. The basic relations and numerical techniques used to obtain a computer code solution of this problem are presented. The validity of the method is illustrated by comparison of experimental and computed results. The effect of this revised subchannel analysis on the hot assembly of a large reactor core is also shown. 14 references. (auth)

45072 PRIMARY COOLANT PUMPS IN NUCLEAR POWER PLANTS. Gaffal, Karl (Klein, Schanzlin und Becker AG, Frankenthal, Ger.). VDI (Ver. Deut. Ing.) Z., 111: 823-8(July 1969). (In German).

The increase in performances of nuclear power plants and the requirements of maximum operational safety and high economy for the coolant circulation resulted in the development of various types of reactor pumps. The problems which must be overcome and the considerations which led to the types of pumps for the various reactor systems are examined. A survey provides information

on the further development of circulating pumps for future sizes of reactor units. (auth)

45073 SUPERCRITICAL HETEROGENEOUS NUCLEAR REACTOR OF THE PRESSURE VESSEL TYPE. Winkler, Franz; Knoedler, Diethelm; Huber, Gerald (to Siemens Aktiengesellschaft). U. S. Patent 3,453,178. Priority date Aug. 26, 1965, Germany.

A reactor core in a heterogeneous nuclear reactor of pressure vessel type moderated and cooled by the same liquid at supercritical temperature and pressure comprises a plurality of fuel elements and superheater elements. Each of the fuel and superheater elements includes a number of fuel rods in lattice-like arrangement, a number of coolant separator tubes surrounding and spaced from the fuel rods respectively, and a flow path having portions extending sequentially intermediate the coolant separator tubes. A common moderator and coolant liquid traverses the portions of the flow path extending intermediate the coolant separator tubes and through the interior of the coolant separator tubes for the fuel elements. The liquid is vaporized in the coolant separator tubes for the fuel elements by heating action of the fuel rods therein. The vaporized liquid traverses the portion of the flow path through the coolant separator tubes for the superheater elements and absorbs heat energy from heating action of the fuel rods therein. (Offic. Gaz.)

45074 NUCLEAR REACTOR PRESSURE VESSELS. (to Gulf General Atomic Inc.). British Patent 1,160,408. Aug. 6, 1969. Priority date Sept. 7, 1966, United States.

REACTOR CONTAINMENT SYSTEMS—seals for, description of gas cooled reactor penetration
REACTORS, GAS-COOLED—containment system for, description of penetration seals for coolant
SEALS AND GLANDS—gas cooled reactor coolant containment system penetration, description of (D.C.C.)

45075 MODELS OF RESISTANCE OF PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Cordelle, F.; Lida, M.; Ausangee, R. Energ. Nucl. (Paris), 11: 276-85(July 1969). (In French).

The state of the art in the construction of prestressed concrete vessels for graphite-gas reactors has made the execution of tests on large scale models of these vessels necessary. The main problems set by the structures of these vessels and the possibilities and limits of these models are discussed. Examples of studies made for the vessels of Chinon III, St-Laurent I, and Bugey I are given. Because of experience secured by these tests and of the improvements in calculation, it seems possible to alter the actual conception of tests on models to study new vessels. (auth)

45076 EXPERIMENTAL STUDY OF COOLANT CROSS-MIXING IN MULTIROD BUNDLES, CONSISTING OF UNFINNED ONE-, THREE-, AND SIX-FIN FUEL RODS. Baumann, W.; Moeller, R. (Institut fuer Reaktorbauelemente, Karlsruhe, Ger.). Atomkernenergie, 14: 297-304(Sept.-Oct. 1969).

Experimental studies of coolant cross-mixing in rod bundles having the geometry of fuel elements in fast-breeder reactors are described. The test bundles contain finned and unfinned rods respectively. According to the experimental results, the mixing rate is primarily a function of the kind of spacers used. In each of the examined cases it is so high that in the communicating bundle channels temperature differences which would inevitably occur in the so-called hot channels without cross-mixing, exist only in a strongly reduced rate. 13 references. (auth)

45077 THE PROBLEM OF THE WORKING GAS OF THE VOLUME COMPENSATION SYSTEM OF THE PRIMARY COOLANT OF STEAM GENERATING PLANTS WITH A WATER-COOLED, WATER-MODERATED REACTOR. Sysoev, V. S. At. Energ. (USSR), 26: 461-2(May 1969). (In Russian).

Although the solubility of H_2, He, N_2, and O_2 in water is not sufficiently well known, the dependence on the solubility under partial pressure may be calculated on the basis of Henry's law. Earlier experimental studies of H. Pray et al., and N. H. Sinev, et al., were reevaluated and presented graphically, showing the correlation between the equilibrium concentration as a function of partial pressure or temperature and the degree of underheating. Analysis of the family of curves obtained revealed that the equilibrium concentration of N_2 and O_2 in water at a constant total pressure above the solution is directly proportional with the degree of undercooling Δt_U of the solution with respect to the saturation temperature T_s at a given total pressure p_{tot}, and tends toward 0 at $\Delta t_U \rightarrow 0$, i.e., if there is no gas in the solution because of boiling. The largest amount of dissolved working gas is found in a relatively "cold" heat transfer agent (T = 180 to 200°C; Δt_U = 150 to 170°C); the dissolved gas arriving at the region is separated out in the free state. (TTT)

Fuels

Refer also to abstract 44024.

45078 (ANL-7537) THE ATTACK ON THE CLADDING OF EBR-II DRIVER FUEL ELEMENT C-249-16. Ruther, W. E.; Claar, T. D.; Matras, S. (Argonne National Lab., Ill.). Mar. 1969. Contract W-31-109-eng-38. 19p. Dep. CFSTI.

An investigation was made to determine the cause of grain-boundary attack in selective areas of the Type 304L stainless steel cladding of a driver fuel element removed from EBR-II. A hypothesis that improper cleaning techniques may have caused the damage was rejected after variations of normal cleaning methods failed to duplicate the phenomenon. Chemical and electron-microprobe analyses, along with metallographic work, indicated that an increase in carbon concentration was associated with the areas of selective attack. Further testing showed that the microstructure of a stainless steel surface that had been intentionally contaminated with a carbonaceous substance before exposure to sodium was essentially the same as the microstructure of the cladding that had been exposed in EBR-II. (auth)

45079 (ANL-7543) LOCATING AND IDENTIFYING THE SOURCE OF THE MAY 24, 1967 FISSION-PRODUCT RELEASE IN EBR-II. Smith, R. R.; Cissel, D. W.; Doe, C. B.; Ebersole, E. R.; Kirn, F. S. (Argonne National Lab., Ill.). Apr. 1969. Contract W-7405-eng-38. 39p. Dep. CFSTI.

The first verified release of fission products to the primary sodium coolant in EBR-II occurred on May 24, 1967. Primary annunciation was given by the fission gas monitor, which indicated an approximately 3000-fold increase in the concentration of short-lived Kr and Xe fission-product species in the Ar cover-gas system. Confirmatory evidence of the release was provided by analyses conducted for ^{133}Xe and ^{135}Xe in the cover gas, and for ^{131}I and ^{137}Cs in the primary coolant. By removing groups of suspect subassemblies, followed by operation of the reactor, the origin of the fission-product release was eventually attributed to an experimental UO_2–PuO_2 fuel element (HOV-4) in irradiation subassembly XO11. (auth)

45080 (DOCKET-50016-20) DEFLECTION PROPAGATION OF FERMI CORE A SUBASSEMBLY WRAPPER CANS. (Nuclear Technology Corp., White Plains, N. Y.). July 1, 1969. 10p. (NTC-1016-8). Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Stress analysis of Fermi Fast Breeder Reactor fuel subassemblies is presented. Results indicate that a pressure of 403 psia will cause plastic deformation of the subassembly can wall, resulting in gross wall deflections. These deflections may be large enough to cause contact with neighboring subassemblies and thereby transmit some of the pressure force to the neighboring can wall. (auth)

45081 (DOCKET-50016-21) EXAMINATION OF FERMI SUBASSEMBLIES M-140, M-127, M-098, AND M-122. Final Summary Report. (Battelle Memorial Inst., Columbus, Ohio). Nov. 1968. 110p. Dep. CFSTI.

For Power Reactor Development Co., Detroit, Mich.

Postirradiation examination of Fermi Fast Breeder Reactor fuel subassemblies M-140, M-127, M-098, and M-122 is described. Each subassembly is examined individually for evidence of distortion or failure and possible causes for the meltdown of fuel. These subassemblies are suspected of being damaged during the October 5, 1966 incident. (auth)

45082 (GA-8787) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report for the Quarters August 1, 1967-July 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Sept. 20, 1968. Contract AT(04-3)-167. 145p. Dep. CFSTI.

CRITICALITY STUDIES—calculation of conceptual plutonium fueled 1000 MW(e) gas cooled fast breeder reactor
HASTELLOY X—radiation effects on mechanical and thermal properties of, measurement of neutron
INCOLOY 800—radiation effects on mechanical and thermal properties of, measurement of neutron
NEUTRONS—effects on mechanical properties of plutonium carbide (PuC)–uranium carbide (UC) and plutonium oxide (PuO_2)–uranium oxide (UO_2)
—effects on mechanical and thermal properties of Hastelloy X, Incoloy 800, and Type 316 stainless steel
PLUTONIUM CARBIDES—PuC–UC, radiation effects on mechanical properties of, measurement of neutron

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, properties of, effects of stoichiometry on mechanical and thermal
—PuO_2–UO_2, radiation effects on mechanical properties of, measurement of neutron
REACTOR FUEL ELEMENTS—development of gas cooled fast breeder power reactor, description of August 1967 to July 1968
—design parameters for gas cooled fast breeder power reactor
—radiation effects on mechanical properties of plutonium oxide (PuO_2)–uranium oxide (UO_2), measurement of neutron
REACTOR, BREEDER—fuel elements for gas cooled fast power, development during August 1967 to July 1968
—core for conceptual 1000 MW(e) gas cooled fast, design comparisons of
REACTORS, FAST—fuel elements for gas cooled breeder power, development during August 1967 to July 1968
—core for conceptual 1000 MW(e) gas cooled breeder, design comparisons of
REACTORS, GAS-COOLED—fuel elements for fast breeder power, development during August 1967 to July 1968
—core for conceptual 1000 MW(e) fast breeder, design comparisons of
REACTORS, POWER—fuel elements for gas cooled fast breeder, development during August 1967 to July 1968
—core for conceptual 1000 MW(e) gas cooled fast breeder, design comparisons of
STAINLESS STEEL—radiation effects on mechanical and thermal properties of Type 316, measurement of neutron
URANIUM CARBIDES—PuC–UC, radiation effects on mechanical properties of, measurement of neutron
URANIUM OXIDES UO_2—PuO_2–UO_2, properties of, effects of stoichiometry on mechanical and thermal
—PuO_2–UO_2, radiation effects on mechanical properties of, measurement of neutron (D.C.C.)

45083 (GA–9229) GAS-COOLED FAST BREEDER REACTOR. Quarterly Progress Report, November 1, 1968–January 31, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 24, 1969. Contract AT(04-3)-167. 108p. Dep. CFSTI.

NEUTRONS—effects on gas cooled fast breeder reactor fuel elements of plutonium oxide (PuO_2)–uranium oxides (UO_2)
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects on gas cooled fast breeder reactor fuel elements of, fast neutron
REACTOR FUEL ELEMENTS—radiation effects on gas cooled fast breeder reactor plutonium oxide (PuO_2)–uranium oxide (UO_2), fast neutron
REACTORS, BREEDER—core development for gas cooled fast, during November 1968 to January 1969
—fuel element development and testing for gas cooled fast, during November 1968 to January 1969
REACTORS, FAST—core development for gas cooled breeder, during November 1968 to January 1969
—fuel element development and testing for gas cooled breeder, during November 1968 to January 1969
REACTORS, GAS-COOLED—core development for fast breeder, during November 1968 to January 1969
—fuel element development and testing for fast breeder, during November 1968 to January 1969
URANIUM OXIDES UO_2—PuO_2–UO_2, radiation effects on gas cooled fast breeder reactor fuel elements of, fast neutron (D.C.C.)

45084 PRESSURIZED WATER REACTOR OPTIMAL CORE MANAGEMENT AND REACTIVITY PROFILES. Melice, Michel (Electrobel, Brussels). Nucl. Sci. Eng., 37: 451-77(Sept. 1969).

A new attempt towards the development of a systematic method for solving the fuel cycling management optimization problem in modern PWR cores is presented. When the infinite multiplication factor k is used as a single variable to describe the fuel distribution over the core at any stage of its life, the analysis of any reloading pattern can be performed on the basis of its corresponding k-map in the X-Y plane, or more simply, on the basis of its equivalent "k-profile" in cylindrical geometry. Conversely, it is shown how the reloading pattern can be synthesized from the k-profile, which becomes, therefore, the main tool of the method. The search for the best k-profile rests on the analysis of the necessary relations existing, for any particular reloading mode (batch, multiregion, salt-and-pepper, etc.) between the k-profiles and cycle times, and on the use of a cycle "internal optimality condition" aiming to maximize the reactivity of the reloading k-profile, and consequently, the cycle life time, with a constraint on the power-peak factor. As a result, the general many-variable cycling problem can be contracted into a single control-variable problem which, in turn, can be separated into the following two simpler tasks: a cycle internal optimization problem consisting of finding the reloading mode and the single control variable which minimize the stationary cycle cost and a cycle external optimization problem aiming to minimize the cost penalty associated with any deviation of the cycling sequence from the optimal stationary cycle. Using the particular class of optimal k-profiles complying with the maximum power (minimum peak factor) condition, the method is applied to the analysis of the stationary and transient cycles of the SENA reactor, with the three-region mixed reload mode. The methods for calculating the optimal profile classes corresponding to an arbitrary peak factor are also indicated. 20 references. (auth)

45085 CYCLE OF Th–U–Pu SYSTEM ON FAST BREEDER. II. Hayasaka, Hideo; Yamamoto, Norio; Watanabe, Noboru (Tohoku Univ., Sendai). Nippon Genshiryoku Gakkaishi, 11: 476-81(Aug. 1969). (In Japanese).

The burn-up of Th–U–Pu system fuel in a fast breeder reactor has been analytically obtained as a solution to the problem of perturbation of a time-dependent depression matrix. In this approach, the addition of fertile material to the system and the extraction of spent fuel out of the breeding system produces a feedback effect on the depression matrix in the form of restrictions imposed upon the concentration of the nuclear species as well as upon the power output of the system. The breeding system is regarded as a closed loop of automatic control with time-variable-parameters (T.V.P. system), and the solution is first obtained by transforming the unperturbed system into canonical form. In general, the system of perturbation is expressed by vector Volterra equation, and its solution obtained as a Neumann series with iterated kernels. Since the two restrictions described above, would be expected to bring about slow variation of the matrix elements with time, the variations of perturbation can be expanded into polynominals of time. The coefficients for the expansion are determined by the conditions of restriction applying on the concentration of the nuclear species. Thus given only the initial conditions, it will be possible to calculate—with any desired accuracy of approximation—the nuclear species, the rate of supply of the fertile materials and the extraction of the fuel at any time. 6 references. (auth)

45086 FUEL SUBASSEMBLY FOR A LIQUID-METAL-COOLED, FAST BREEDER NUCLEAR REACTOR. Finch, Lester M.; Anthony, Andy J. (to United States Atomic Energy Commission). U. S. Patent 3,468,757. Sept. 23, 1969.

A fuel subassembly for a liquid-metal-cooled nuclear reactor operating predominantly on fast neutrons which includes a compact bundle of elongated fuel pins disposed within a shroud is described. The subassembly contains an active core and a fission-gas plenum zone downstream of the fuel. The shroud is of expanding cross section downstream of the active core to provide an annular coolant passageway of increasing cross section. (AEC)

45087 FUEL ELEMENT FOR A NUCLEAR REACTOR. Grant, W. L. (to Atomic Energy Board). Canadian Patent 810,350. Apr. 8, 1969. Priority date June 11, 1964, South Africa.

Fuel assemblies are described for use with granular fuel and liquid metal coolant, which flows between voids in the granules. A novel feature is the local formation of solid plug of coolant by freezing so that a mass of fuel granules may be held where desired. The plug is melted when it becomes necessary to move the fuel granules. A method is outlined for withdrawing fuel batchwise from the nuclear space in the fuel channel by providing alternately frozen plugs of coolant at different elevations and maintaining one plug while another is melted. Inlet and outlet ports at the top are provided which communicate with the fuel space. This allows for entrance and exit of fuel granules and coolant. A heat exchanger is included in this circuit. (F.S.A.)

45088 FUEL ELEMENT FOR A NUCLEAR REACTOR. Becker, K. M. (to Aktiebolaget Atomenergi). Canadian Patent 813,000. May 13, 1969. Priority date July 24, 1964, Sweden

In a boiling water reactor, the tubular fuel elements are contained in a channel which has fissile material in its walls. The fuel channel tube also contains a space on its outer surface for an insulating gas so that the fission heat may be absorbed almost completely by the coolant. The surface heat flux of the tube is higher than that of the fuel rods. The structure of the fuel rods and the containing fuel channel tube are described in detail. (auth)

45089 THERMOELECTRONIC ENERGY CONVERTERS FOR NUCLEAR REACTORS. Lazare-Chopard, G.; Merard, R. (to Commissariat a l'Energie Atomique). Canadian Patent 811,900. Apr. 29, 1969. Priority date June 9, 1964, France.

The converter comprises elementary nuclear fuel bars constituting a composite bar, a single continuous elongated cylindrical anode structure encompassing the composite bar and coaxial

with it. The anode structure consists of axially spaced elementary cylindrical anodes and relatively thin annular pleated metal connecting means joining the elementary anodes. The connecting means has a linear resistance in the axial direction exceeding that of the elementary anodes. Each connecting means has a developed length which is much greater than the spacing between adjacent elementary anodes. The elementary bars are individually connected electrically to the elementary anodes. (F.S.A.)

45090 SHOCK ABSORBER. Gaudez, Jean-Claude; Roche, Roland; Trelin, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,160,219. Aug. 6, 1969. Priority date Oct. 28, 1966, France.

REACTOR FUEL ELEMENTS—shock absorber for gas cooled heavy water moderated power, description of stress failing flared sleeve
REACTORS, GAS-COOLED—fuel element shock absorbers for heavy water moderated power, description of stress failing flared sleeve
REACTORS, HEAVY WATER-MODERATED—fuel element shock absorbers for gas cooled power, description of stress failing flared sleeve
REACTORS, POWER—fuel element shock absorbers for gas cooled heavy water moderated, description of stress failing flared sleeve (D.C.C.)

Operation and Economics

45091 (AECL-3367) THE FUTURE OF THE NUCLEAR BUSINESS IN CANADA. Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 18p. (CONF-690615-2). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

From 9th Annual Nuclear Association Conference, Montreal, Canada.

The CANDU concept currently has a competitive advantage where medium level capital charge rates apply. All likely trends will improve this position to such an extent that it will become superior even where capital charge rates as high as 12% apply. The domestic volume for provision and installation of nuclear steam supply systems will reach $200 million per annum within the next 10 years. Maturity of a nuclear equipment industry requires a business volume for any one product amounting to $10 million per year, where the supplier adds a minimum of 30% of the product value and engages fully in all normal industrial functions: development, design, direct shop activity, all necessary indirect shop and manufacturing engineering activities, marketing, selling and the making of profits. A number of nuclear equipment and materials industries will mature well before 1980 based on domestic requirements only. Export orders will advance the earliest dates of maturity by two to four years. (auth)

45092 (LA-4207) ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX). Quarterly Status Report for Period Ending April 30, 1969. (Los Alamos Scientific Lab., N. Mex.). July 10, 1969. Contract W-7405-eng-36. 14p. Dep. CFSTI.

Operations during February to April 1969 are described. Core loading and fuel worth measurements are presented. Test programs and maintenance requirements are reviewed. Fuel element fabrication and corrosion observations are described. 3 references. (auth)

45093 (ORNL-4116) A REVISION OF COMPUTER CODE POWERCO (COST OF ELECTRICITY PRODUCED BY NUCLEAR POWER STATIONS) TO INCLUDE BREAKDOWNS OF POWER COST AND FIXED CHARGE RATES. Salmon, Royes (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 149p. Dep. CFSTI.

A computer code, POWERCO-25, for calculating the levelized cost of electricity produced by nuclear power stations was described previously. The calculation was made by a discounted cash flow technique, rather than by the fixed charge rate procedure. Required input data included a schedule of all cash expenditures over the life of the project, except for federal income taxes, which were calculated internally. State and local taxes, interim replacements, and insurance costs had to be precalculated externally and treated as part of the annual cash expenditures. The output from the code included a tabulation of the cash flows over the project lifetime, and showed the gradual reduction of the outstanding investment to zero. A new version of the code, POWERCO-50, which contains several changes is described. The calculation of state and local taxes, interim replacements, and property insurance is now made internally; tax rates and other necessary constants for the calculation of these items are now required as part of the input data. The fixed charge rates on capital now include the effects of state and local taxes, interim replacements, and property insurance, in accordance with general usage. This permits the fixed charge rates generated by the code to be compared directly with those given in other sources. In POWERCO-50 the power cost is separated into four components, representing the cost contributions due to plant capital, nonfuel working capital, fuel cycle costs, and reactor operating and maintenance expense. Fixed charge rates on depreciable and nondepreciable capital are also broken down into their components. The maximum number of time periods in the project lifetime has been increased from 180 to 500. A FORTRAN listing of POWERCO-50 and the results of example problems are included. (auth)

Safety and Siting

45094 (AECL-3332) IMPROVING THE THERMAL EFFICIENCY OF CANDU'S. Hurst, D. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 10p. (CONF-690615-3). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

From 9th Annual Nuclear Association Conference, Montreal, Canada.

Improved thermal efficiency of water-cooled nuclear power plants could give significant economic rewards. The work of an AECL Committee whose task is to outline technical development necessary for the realization of the economic potential of higher efficiency is discussed. (auth)

45095 (BMI-1867) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, April-June 1969. Morrison, David L.; Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). July 1969. Contract W-7405-eng-92. 46p. Dep. CFSTI.

OXYGEN—dissolution in Zircaloy fuel element cladding, effects on brittle failure mechanisms of
REACTOR FUEL ELEMENTS—cladding failure in boiling water, effects of oxygen dissolution in Zircaloy
—cladding swelling during coolant loss accidents in boiling water, heat transfer and metal creep model for
REACTOR SAFETY—coolant loss accidents in boiling water and pressurized water reactors, analytical description of
REACTORS, BOILING—coolant loss accidents in, evaluation of data for analytical description of
—kinetics equations for, finite difference method for solution of multigroup space-time
—fuel element failure in, effects of coolant flow blockage on propagation of, (T)
—fuel element cladding failure in, effects of oxygen dissolution on Zircaloy, (E/T)
—fuel element cladding swelling during coolant loss accidents, heat transfer and metal creep model for
—emergency core cooling system performance during coolant loss accidents, thermal hydraulic computer codes for analysis of
—cooling channel heat transfer characteristics during coolant loss accidents in, (E/T)
REACTORS, PRESSURIZED WATER—coolant loss accidents in, evaluation of data for analytical description of
—kinetics equations for, finite difference method for solution of multigroup space-time
—fuel element failure in, effects of coolant flow blockage on propagation of, (T)
—fuel element cladding failure in, effects of oxygen dissolution on Zircaloy, (E/T)
—fuel element cladding swelling during coolant loss accidents, heat transfer and metal creep model for
—emergency core cooling system performance during coolant loss accidents, thermal hydraulic computer codes for analysis of
—cooling channel heat transfer characteristics during coolant loss accidents in, (E/T)
ZIRCALOY—oxygen dissolution in fuel element cladding of, effects on brittle failure mechanisms of (H.D.R.)

45096 (ORNL-NSIC-67) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-20. (Oak Ridge National Lab., Tenn.). July 1969. Contract W-7405-eng-26. 311p. Dep. CFSTI.

References are cited on significant developments in the safety aspects of: reactor design, construction, and operation; fuel fabrication; spent fuel processing; waste disposal; and radioisotope handling. The citations are sorted into 19 general subject categories, and keyword and author indexes are included. (H.D.R.)

45097 (TID-3525(Rev.5)(Suppl.4)) REACTOR SAFETY. A Literature Search. Raleigh, Henry D. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1969. 155p. Dep. CFSTI.

Included are 725 citations to references on safety aspects of nuclear reactor design, siting, materials, engineered safeguards, and operating procedures covering the period from January 1967 through December 1968. Reports cited concern hazards analyses of entire facilities to satisfy construction and operation permit requirements, evaluation of reactor systems and components reliability, and analyses of the consequences of potential accident conditions. Subject, author, corporate author, and report number-availability indexes are included. (auth)

45098 ECONOMIC MODEL FOR DETERMINING THE OPTIMUM LAYOUT OF NUCLEAR POWER-STATION SITES TAKING INTO ACCOUNT THE STRUCTURAL DEVELOPMENT OF THE INTER-CONNECTED NETWORK. PART 2. Gerisch, G. Energietechnik, 18: 541-4(Dec. 1968). (In German).

The secondary conditions for the economic model are derived and the possibility of further simplification of the model is examined. (UKAEA Info. Bull.)

45099 BLAST SHIELD FOR NUCLEAR REACTOR. Finch, Lester M. (to United States Atomic Energy Commission). U. S. Patent 3,466,227. Sept. 9, 1969.

An energy-absorbing blast shield for a fast-reactor core is described. The core is surrounded by a plurality of nested, radially spaced cylinders and by a plurality of tubes between the cylinders. Beneath the core lie sets of tubes and flat sheets separating the sets of tubes. (AEC)

Power Conversion Systems

45100 (CONF-681064-4) BOILERS FOR NUCLEAR POWER STATIONS. PART A. BOILERS FOR GAS COOLED REACTORS. PART B. BOILERS FOR SODIUM COOLED REACTORS. Shaw, T.; North, R. S. (Part A) (International Combustion Ltd., Derby (England)); Worley, N. G. (Part B) (Babcock and Wilcox Ltd., London (England). Atomic Energy Dept.). [1968]. 46p. Dep.

From British Nuclear Forum and Deutsches Atomforum Meeting, Frankfurt am Main, Germany.

The once-through design described in Part A comprises cylindrical boiler units distributed around the reactor core in an annulus between the steel pressure cylinder and the concrete pressure vessel. A cross counterflow is achieved by helical coil arrangements. Economic considerations, thermal performance, tube support systems, and boiler integrity are discussed. The design of sodium steam generators is discussed in Part B, and the advantages and disadvantages of once-through and forced circulation systems are considered. The design and materials selected for the PFR are described, and model water flow experiments and tube support plate fretting tests are outlined. (UK)

Research and Test Reactors

Refer also to abstracts 43475, 43492, 43944, 44809, 45046, and 45047.

45101 (AD-687501) NORTH FACE RESEARCH ACCOMMODATIONS AT THE AIR FORCE NUCLEAR ENGINEERING TEST FACILITY. Fasano, A. N.; Clark, D. T. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). 1966. 97p. (AFIT-TR-66-1). CFSTI.

The experimental research facilities located on the north face of the Air Force Nuclear Engineering Test Facility (AFNETF) are described. This facility is a 10 megawatt nuclear reactor. These north face facilities include the horizontal and vertical beam tubes, the thermal column, and associated support equipment. (USGRDR)

45102 (AERE-R-6105) ALUMINA FORMATION ON THE DIDO-PLUTO CLASS OF REACTORS. Smith, E. T.; Aitchison, G. F.; Monahan, J. (Atomic Energy Research Establishment, Harwell (England)). May 1969. 52p. Dep. CFSTI (U. S. Sales Only). UK 5s. 6d.

There is ample evidence to show that control of the pH (or pD) value at an optimum value appears to be one method of preventing Al_2O_3 formation, as has been demonstrated on the DIDO, PLUTO, DMTR and DR3 reactors. The HIFAR reactor has remained free from Al_2O_3 formation, and this has been attributed to the maintaining of high standards of purity both in the reactor He blanket and in the D_2O circuit; the purity of the latter has been achieved by continuous ion-exchange purification using a mixed-bed column which has resulted in a higher pD value. Several techniques have been successfully used for the removal of suspended Al_2O_3, the only problem is the selection of the best method for the reactor system being assessed. A survey of the various experiences on several reactors is given which may be of use to future workers in this field. 30 references. (auth)

45103 (BNWL-1011) FFTF REACTOR VESSEL CONCEPT EVALUATION SUMMARY. Oakley, D. J. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 128p. Dep. CFSTI.

Supersedes BNWL-1001.

Two proposed design concepts of the FFTF reactor pressure vessel were comparatively evaluated for the purpose of selecting the configuration demonstrating the greater overall advantage. The two concepts, the Annular Inlet and Piped Bottom Inlet, differ primarily in location of inlet nozzles, method of vessel wall cooling, and containment of system inlet pressure. Principal areas of the study involved methods of fabrication, ease of inspection, thermal balance, individual design features, accident containment capabilities, shock and vibration responses, heat transport and emergency cooling factors, and cost. Results of the detailed evaluations were concluded, from the standpoint of overall advantages, to favor the Piped Bottom Inlet concept. (auth)

45104 (BNWL-1130) EVALUATION OF TECHNIQUES FOR THE CONTROLLED ADDITION OF IMPURITIES TO FFTF CLOSED LOOPS. McCown, J. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

One of the most important variables in the FFTF closed loop testing program will be coolant purity, since variations in impurity levels could significantly alter long term test results. It will probably be necessary, therefore, not only to monitor the impurity levels but to adjust them by controlled concentration changes to meet the needs of various tests. It is concluded that methods are available for adding known amounts of oxygen and hydrogen to Na systems. In the case of carbon, it has been demonstrated that addition methods can increase the concentration for some carbon species such as cyanide and carbide. The total carbon content or carburization potential value for a system can be shifted by addition techniques but cannot necessarily be adjusted to a predetermined value. 20 references. (auth)

45105 (DOCKET-50231-37) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Supplemental Safety Evaluation by the Division of Reactor Licensing. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 19, 1969. 16p. Dep. CFSTI.

A supplemental safety review which considers operation of the Southwest Experimental Fast Oxide Reactor (SEFOR) up to 20 MW(t) is given. The supplement refers to the original safety review which authorized 1 MW(t) operation of the reactor. (M.L.S.)

45106 (INR-968) NEUTRON MACRODISTRIBUTION AND BUCKLING DETERMINATION IN WWR-SM CORES. PART I. NORMAL LATTICES. Adamski, L.; Jozefowicz, K.; Jozefowicz, E. T. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 51p. Dep. CFSTI (U. S. Sales Only).

Thermal, epithermal, and fast neutron distributions in various configurations of the normal-lattice WWR-SM core have been measured. Axial and radial buckling components and extrapolation lengths have been derived. Experimental results are compared with the Polish and German theoretical calculation. 7 references. (auth)

45107 (INR-1035) THE SYSTEM FOR DETECTION OF FISSION GAS RELEASE FROM WWR-SM FUEL ELEMENTS. Filipyak, B. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 15p. (In Russian). Dep.

The method used and results of measurements from the initial period of operation of the system installed in the WWR-SM EWA reactor in Swierk are evaluated. This system also permits the detection and determination of damage in target material containers used for reactor irradiations. Some typical cases of container rupture are discussed. (auth)

45108 (ORNL-TM-2608) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JANUARY-MARCH 1969. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). June 10, 1969. 136p. Dep. CFSTI.

The average power level at the ORR was 29.8 MW, while the reactor operated 87% of the time. Eighteen fuel elements were declared spent during the quarter, while 25 new fuel elements

were placed in service. The average burnup of the elements declared spent was 48.8%. The reactor was shut down on 11 occasions, 6 of which were scheduled. Two end-of-cycle shutdowns accounted for 98% of the total downtime. The chamber for the No. 1 log-N instrument channel, a dual-type chamber, failed, causing an unscheduled shutdown, and was replaced. The base plate for the No. 2 primary pump was replaced because of frequent alignment problems. The base plates for the other two primary pumps will also be replaced. A rather significant change was made in the core configuration to enhance the flux at the beam holes. This was accomplished by exchanging the isotope stringer, iodine stringer, and Be reflector from the east side of the core for fuel from the south side, thus maintaining approximately the same fuel loading. Following the core change, the flux in the fuel region of the lattice was measured; and the shim rods were calibrated. The reactivity worth of an I_2 production stringer was measured as +0.015% $\Delta k/k$, while the reactivity worth of a special Ni-plated element in lattice position E-3 was found to be −0.025% $\Delta k/k$. A study of the effectiveness of the building containment during high winds, conducted over the past two years, indicates that the pressure inside the building was never positive with respect to the outside. (auth)

45109 A SYSTEM FOR RAPID RADIOCHEMICAL SEPARATIONS FROM AQUEOUS SOLUTIONS. Schuessler, H.-D.; Grimm, W.; Weber, M.; Tharun, U.; Denschlag, H. O.; Herrmann, G. (Univ., Mainz). Nucl. Instrum. Methods, 73: 125-31(1969).

For the study of short-lived fission products, an automatic system has been developed that allows irradiation of aqueous solutions sealed in polystyrene capsules, chemical separation of the radioactive products formed, and the counting process to start, all within a few seconds. Irradiations are performed in a pneumatic tube system installed in a horizontal beam hole of a reactor. The capsule is projected into a separation apparatus where it breaks by impact. Its content is then sucked through a thin reactive layer that takes up the desired product. The whole sequence of irradiation, transportation, chemical separation, and counting is controlled by automatic timers. The adaption of this technique to a conventional pneumatic system is also described. (auth)

45110 APPRAISAL STUDY OF REPORTED OPERATING EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. IV. RAPSODIE FBR. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co.). Nippon Genshiryoku Gakkaishi, 11: 482-8(Aug. 1969). (In Japanese).

The operating experience of Rapsodie FBR is reviewed and evaluated. 12 references. (auth)

Rocket and Space Reactors

45111 (GA-9046(Rev.)) REACTOR REQUIREMENTS FOR FIRST GENERATION THERMIONIC NUCLEAR ELECTRIC PROPULSION. Ingber, J. F.; Higdon, D. T. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 15, 1969. Contract AT(04-3)-167. 36p. (CONF-690319-2). Dep. CFSTI.

From AIAA 7th Electric Propulsion Conference, Williamsburg, Va.

Data are presented to show the interaction between reactor and mission requirements for first generation unmanned thermionic nuclear electric propulsion applications. A Titan III F/Centaur launch vehicle is assumed. Reactor lifetime requirements are given in terms of payload capability, and performance for different power levels is presented as a function of mission constraints, with major emphasis on 50 and 100 kW(e) power plants. Significant results are that thrust times or reactor full power operating times generally can be reduced by a factor of two or three from the optimum while maintaining useful payloads, and that a single power plant is applicable to a broad range of nuclear electric solar system missions with a power level that is compatible with projected space auxiliary power requirements. (auth)

45112 (N-69-25399) ANALYSIS OF CAVITY REACTOR EXPERIMENTS. Henderson, W. B.; Kunze, J. F. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Jan. 1969. Contract C-67747-A. 122p. (NASA-CR-72484; GEMP-689). CFSTI.

Cavity reactor critical experiments on a large cavity (120 cm × 180 cm) reflected by 90 cm of D_2O are analyzed. These experiments had core loadings ranging from 10 to 90 kg, and both gas cores and simulated gas cores (using thin sheet fuel) were studied. The principal analytical efforts were devoted to the UF_6 gas core configurations. The sensitivity of various parameters, such as energy group structure, spatial detail, diffusion vs transport theory, and one vs two dimensional calculations are analyzed. It was concluded that existing two-dimensional transport codes and second generation computers are generally not adequate for cylindrical cavity reactor analysis. (auth) (STAR)

45113 (N-69-29593) NEUTRONIC COMPARISON OF BERYLLIUM OXIDE AND MOLYBDENUM FOR MOVABLE REFLECTOR CONTROL OF A FAST-SPECTRUM REACTOR. Whitmarsh, Charles L. Jr.; Mayo, Wendell (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1969. 26p. (NASA-TM-X-1822). CFSTI.

A neutronic comparison of BeO and Mo as the major constituents of axially translating radial reflectors for the reactivity control of a fast-spectrum reactor is made. Both one- and two-dimensional transport calculations are used. The analysis indicates that the multiplication factors, power distributions, and reactivity control worth are nearly the same for both types of reflector materials. The normally higher worth of the beryllium oxide reflector is reduced because of the presence of molybdenum canning material in the reflector and a tantalum alloy pressure vessel between the core and the reflector, and the need to provide cooling and helium containment. (auth) (STAR)

45114 (TID-25121) DYNAMICS OF A FAST REACTOR WITH IN-CORE THERMIONIC CONVERTERS. Annual Report No. 2, September 1, 1967–August 31, 1968. Brehm, R. L.; Hetrick, D. L.; Guppy, J. G.; Kearns, K. D.; Schmidt, T. R. (Arizona Univ., Tucson. Dept. of Nuclear Engineering). Nov. 1968. Contract AT(04-3)-670. 100p. Dep. CFSTI.

The dynamic behavior of space reactors utilizing in-core thermionic diodes is investigated. Areas of study include: the detailed development of the two-region stability model; the development of a computer program describing an in-core thermionic reactor system in detail; and generalized studies in nonlinear reactor dynamics with particular application to the two-region model of the thermodynamic reactor. 26 references. (D.C.C.)

45115 NONINTEGRAL BURN OF NUCLEAR ROCKETS: AN APPROACH TO LOW-COST SPACE EXPLORATION. Gronich, S.; Holl, R. J.; Johnson, K. P. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). J. Spacecraft Rockets, 6: 723-9(June 1969).

A new nuclear stage concept is presented which provides maximum exploitation of the performance potential of the solid core nuclear rocket. This is nonintegral burn (NIB) in which the same stage is restarted to perform more than one mission propulsive step. Performance with NIB is compared with the use of discrete stages for each mission step and with active vampire, which transfers propellant between stages during operation. Both NIB and active vampire exhibit superior performance compared to the discrete stage approach, but NIB shows a significant advantage over active vampire with present NERVA engine lifetime limitations. NIB operations and stage systems are defined and evaluated to demonstrate the feasibility of the concept. NIB provides efficient, modular nuclear transportation for diverse mission objectives employing common stages, fully utilizing booster capability, and greatly reducing launches. Furthermore, it can most efficiently exploit advanced mission concepts such as elliptic planetary capture orbits, offering the potential of performing a manned Mars landing mission with only two launches of a Saturn MLV-23(L) class booster. The concept promises significant reduction of post-Apollo space program costs. (auth)

Process Heat and Desalination Reactors

45116 (JUL-576-RG) THE ENERGY SITUATION IN THE FEDERAL REPUBLIC OF GERMANY AND THE POSSIBILITIES OF FUTURE DEVELOPMENT. Kugeler, Kurt; Kugeler, Manfred (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Jan. 1969. 52p. (In German). Dep.

An analysis is made of the present-day structure of energy consumption in the German Federal Republic. The changes to be expected in the near future are briefly described. Several possible methods for the gas reduction of fossil fuels (natural gas, petroleum, lignite, and coal) with the help of nuclear reactor heat are described. The technical problems connected with these methods are indicated. The question of the utilization of the gases produced is then investigated. 21 references. (tr-auth)

Marine and Portable Power Reactors

Refer also to abstracts 43414 and 43444.

45117 (AD-685818) 1968 ANNUAL SUMMARY REPORT, ENVIRONMENTAL RADIATION MONITORING PROGRAM, SM-1A NUCLEAR POWER PLANT, FORT GREELY, ALASKA. Clements, Lynn C.; Stricklin, Herbert L. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). Mar. 1969. 14p. (ED-6907). CFSTI.

Tables of the environmental radiation monitoring data collected during the period 1 January 1968 to 31 December 1968 are presented. (auth) (USGRDR)

45118 (AD-686341) TECHNICAL EVALUATION OF THE PM-1 NUCLEAR POWER PLANT AND RELATED PROGRAMS. Technical Evaluation Report, November 9, 1957-April 11, 1968. Peura, Edwin W. A. (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). Dec. 1968. 88p. (ED-6905). CFSTI.

A technical evaluation of the PM-1 Nuclear Power Plant and related programs is presented. The PM-1 Program is documented from its inception (November 1957) to plant shutdown (April 1968). The PM-1 Nuclear Power Plant design objectives and requirements are tabulated. PM-1 plant systems, which constituted "state of the art" advances are discussed and evaluated. Atomic Energy Commission programs related to the PM-1 are described. Conclusions dealing with the PM-1 accomplishments and the land based nuclear power program are presented. Recommendations for future Nuclear Power Program effort are tabulated. (auth) (USGRDR)

45119 (RCN-97(Vol.4)(Pt.2)) THE NERO DEVELOPMENT PROGRAMME. VOLUME IV, PART II. REVIEW OF RESEARCH AND DEVELOPMENT WORK; DEVELOPMENT OF COMPONENTS. (Reactor Centrum Nederland [The Hague]). May 1969. Contract 007-61-6-PNIN. 275p. Dep.

Volume IV covers the experimental work performed in order to specify the design of several components of the NERO Reactor installation, such as the steam-generator and superheater, the pressurizer, the emergency cooling system, the primary circulating pumps, and the jet pumps for recirculation inside the reactor vessel. A description of the proposed design for the control rod drive is given. Some of the first results of measurements of burn-out values on electrically heated rods, in the geometry proposed for the NERO-design, are described. (auth)

45120 VENTILYATSIYA I KONDITSIONIROVANIE VOZDUKHA NA ATOMNYKH SUDAKH. (Ventilation and Air Conditioning in Nuclear Powered Ships). Zubarov, D. L.; Ruban, V. M. Leningrad, Izdatel'stvo Sudostroenie, 1968. 340p.

Design and construction of ventillation and air conditioning systems in nuclear powered ships are discussed. The first chapter covers the problems of radiation protection in nuclear ships, air purification and decontamination, waste storage, ventilation of the ship's radiochemical laboratory, machine departments, living quarters, wash-houses, etc., air filtration equipment for absorption and adsorption of aerosols and gases. The second chapter considers the specific conditions of nuclear powered submarines and the special radioprotection and air-conditioning requirements. Thermoelectrical cooling and heating of ships are discussed. A supplementary chapter correlates the basic requirements in Soviet Russia and foreign classifications for safety and air conditioning in nuclear ships. 134 references. (R.V.J.)

45121 PRACTICAL USE OF NUCLEAR SHIPS. Kaiun, No. 499, 72-9(Apr. 1969). (In Japanese).

A report on the economics of nuclear ships is described. The advent of nuclear ships appears to be in terms of giant tankers and container ships of giant size with high speed. It results from the characteristics of the increased cruising range and the increase in the cargo capacity due to small amount of nuclear fuel in a nuclear ship. In the analysis of the economy of nuclear ships, therefore, the two factors, high navigation speed and giant tonnage, were taken as parametors. The nuclear ships and the conventional ships, for transport of 1000, 2000 and 3000 shipping containers, are compared, concerning speeds of 24, 27, 30, and 33 knots. (NSA of Japan)

45122 NUCLEAR MERCHANT SHIP ECONOMICS: A TWENTY-YEAR FORECAST. Kesterman, Frank. Nav. Eng. J., 81: 113-19(Apr. 1969).

Equivalent 30-knot nuclear and fossil-fueled containership systems operating on Trade Route 12 between the U. S. East Coast and the Far East were analyzed for 1968 costs. The effect of certain conditions and long-term trends on nuclear ship economics for systems beginning in 1984 was analyzed. If the nuclear ships described are built today under the provisions of the Magnuson and Garmatz bills, then the nuclear ship operating on TR-12 with no operating subsidy shows a 35 percent return on the owner's invested capital. With no subsidy of any kind, nuclear and conventional ships constructed in 1984 and operated on Trade Route 16 (U. S. East Coast-Australia) could produce a return on the owner's investment of 16 and 24% respectively, if costs and revenues ($1,000/container) are escalated 3.5% by inflation. (BBB)

Production Reactors

45123 (DUN-5890) N-REACTOR CONFINEMENT SYSTEM SAFETY ANALYSIS. ITERIM REPORT ON FOG SPRAY RELIABILITY. Cole, D. E. (Douglas United Nuclear, Inc., Richland, Wash.). July 10, 1969. 24p. Dep. CFSTI.

An analysis is being made of the reliability of the N-Reactor confinement system to control a fission product release that could result from a nuclear safety incident. Interim results are presented on the reliability of the fog spray subsystem, an independent portion of the confinement system. The analysis employs fault tree techniques to describe system failure conditions and a Monte Carlo simulation computer program to evaluate the fault tree. The subsystem and component failure combinations that will result in insufficient fog spray protection under incident conditions are described. Seven comparative analyses were made and results on the reliability for each set of conditions are tabulated. (H.D.R.)

Reactor Theory

Refer also to abstracts 45106 and 45114.

45124 (BNL-50157) NOAH. Lellouche, Gerald S. (Brookhaven National Lab., Upton, N. Y.). Jan. 1969. 19p. Dep. CFSTI.

NØAH is a code in the NØMURK dynamics system which solves the one-energy group, one-dimensional space-time diffusion equation accounting for temperature and xenon feedback. (auth)

45125 (BNWL-1119) REVIEW OF HEAVY WATER REACTOR PHYSICS. Uotinen, V. O.; Schmid, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 86p. Dep. CFSTI.

The status of heavy water reactor statics studies, physics studies involving time independent phenomena, is reviewed. On the basis of this review some areas are indicated where further work is necessary. The development of calculational methods is discussed, and specific heavy water reactor physics experimental and analytical studies are discussed to indicate the state-of-the-art. 165 references. (H.D.R.)

45126 (RISO-M-924) COMPUTER ABSTRACTS. Hansson, Leif (ed.) (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1969. 53p. Dep. CFSTI (U. S. Sales Only).

Abstracts of sequences and computer programs at AEK which are considered to be of general use are listed. Programs of more specific use are not listed. (auth)

45127 (TID-25131) NONLINEAR OSCILLATIONS AND STABILITY OF A NUCLEAR REACTOR WITH TWO REACTIVITY FEEDBACKS. Schmidt, Theodore Reinold Jr. (Arizona Univ., Tucson. Dept. of Nuclear Engineering). June 1969. 170p. Dep. CFSTI.

Thesis.

The autonomous nonlinear differential equations describing the dynamic behavior of nuclear reactors with two reactivity feedbacks are analyzed for stability and for the possibility of nonlinear oscillatory solutions. Fourier series expansions of the reactivity and power are used to search for limit cycles, successive approximations being generated by starting from the linear results. Higher approximations including feedback from higher harmonic frequencies are derived for not only the amplitude of the reactivity but also the amplitude of the power. The effective lifetime model and the prompt jump approximation with one group of delayed neutrons are the two models used for the neutron kinetics. The most general linear heat transfer equations for two regions are described and the linear transformation for decoupling the equations is derived. A special set of two-region heat transfer equations is discussed which describes the heat transfer in a nuclear reactor with in-core thermionic converters. Linear stability is examined by applying the Routh criterion and plotting stability boundaries in a parameter space of reactivity coefficients. Nonlinear stability is discussed in terms of Welton's criterion, boundedness, finite escape times, and limit cycles. The results obtained with the Fourier series method are

compared with exact solutions obtained from analog and digital computations. 33 references. (auth)

45128 (WAPD-TM-891) WANSY: A PROGRAM TO SOLVE THE STATIC TWO-DIMENSIONAL GROUP DIFFUSION EQUATIONS BY SYNTHESIS METHODS. Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT-11-1-GEN-14. 54p. Dep. CFSTI.

WANSY is a synthesis program that combines one-dimensional trial functions obtained from normal, adjoint or direct input WANDA solutions via axially dependent mixing coefficients to yield two-dimensional flux shapes. The trial functions may be axially discontinuous (different sets of trial functions may be used in different axial regions), and different numbers of trial functions may be used in different axial regions. The synthesis approximation may be group-dependent, partially or totally group-collapsed, and weight function scaling factors may be input to improve collapsed group synthesis solutions. The synthesis approximations and required input are described. 13 references. (auth)

45129 SPACE-ENERGY FLUX SYNTHESIS IN TRANSPORT THEORY. Lancefield, M. J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 37: 423-42(Sept. 1969).

The efficacy of the overlapping group method in fast-reactor analysis is investigated and tested on an idealized fast-reactor configuration. A full transport-theory treatment is adopted and the overlapping group equations are derived by the indirect use of a variational principle. A number of refinements to the basic method have been examined and serve to demonstrate that with a judicious choice of variational functional and trial functions it is possible to obtain accurate estimates not only of the reactivity and other integral quantities but also of the detailed flux. These include: leaving both the space/angle and energy dependence of the trial functions to be determined by the variational principle, incorporating discontinuous trial functions, and the use of a new variational principle for criticality problems that leads to estimates of homogeneous functionals of the unknown flux. 24 references. (auth)

45130 STABILIZING CONTROL FUNCTIONS. Sandquist, Gary M. (Univ. of Utah, Salt Lake City). Nucl. Sci. Eng., 37: 443-50(Sept. 1969).

A method for determining stabilizing control functions for any first-order controllable system is presented. Examples of stabilizing feedback control are examined and corroborated for stability using the second method of Liapunov. Consideration of a general class of arbitrary degree stabilizing feedback-control functions reveals that linear feedback control produces the greatest damping. Examination of signal error and time delay in the control function shows that highly damping control can result in system oscillation. Finally the method is extended to systems of higher order and a stabilizing control function is found for the reactor-kinetic equations even with unmonitored delayed neutrons if the linear feedback-control gain is $>\beta/l$. 6 references. (auth)

45131 ENERGY-DEPENDENT NEUTRON TRANSPORT THEORY NEAR A TEMPERATURE DISCONTINUITY. Gritton, Eugene C. (RAND Corp., Santa Monica, Calif.); Leonard A. Nucl. Sci. Eng., 37: 397-409(Sept. 1969).

An exact solution of the energy-dependent Boltzmann transport equation in the region near a temperature discontinuity is obtained for a nonabsorbing medium which is infinite in extent and has a temperature T_1 in one half space and T_2 in the other. The scattering cross section is assumed to be energy independent, and the scattering transfer kernel is represented by a degenerate-kernel approximation to the heavy-gas model. The method of solution is based upon a space-dependent thermalization theory developed earlier using the formalism of Case. Numerical calculations of both the scalar neutron flux and the total neutron density are included for various temperature ratios and neutron-to-moderator mass ratios. These results are compared with diffusion theory to assess the accuracy and range of validity of diffusion theory. For small temperature discontinuities, both diffusion theory and transport theory give very nearly the same value of the total neutron density at the interface. Away from the interface, a discrepancy between these theories becomes apparent because diffusion theory incorrectly predicts the energy-mode relaxation lengths, thus giving rise to an incorrect spatial dependence. Diffusion theory predicts the diffusion lengths accurately only when the energy exchange between the diffusing neutrons and the moderator material is weak. In addition, diffusion theory is found to become progressively less accurate for the higher energy modes. Thus, as the higher energy modes become more important, such as for a larger neutron-to-moderator mass ratio or for a larger temperature discontinuity, transport theory calculations of the neutron flux must replace the diffusion theory analysis. 17 references. (auth)

45132 NUMERICAL METHOD FOR SOLVING THE NEUTRON TRANSPORT EQUATION IN FINITE CYLINDRICAL GEOMETRY. Takeuchi, Kiyoshi (Ship Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 6: 466-73(Aug. 1969).

A method is presented which provides a numerical solution to the steady state, energy dependent neutron transport equation for finite cylindrical geometry, with anisotropic treatment of elastic scattering and isotropic treatment of inelastic scattering. The main characteristic features of the method are the use of quasi-cartesian coordinates and the application of discrete ordinate numerical integration. A difference form of the Boltzmann equation is derived as the final expression for machine computation. Comparisons are given of the numerical solutions with an analytical solution for a constant source distribution, and with NIOBE calculations and experimental spectra for neutron transport in water, with good agreement obtained between them. 13 references. (auth)

45133 INFLUENCE OF EXTERNAL PERTURBATIONS ON THE STABILITY BEHAVIOR OF NUCLEAR POWER REACTORS. Schwalm, D. (EURATOM, Ispra, Italy). Atomkerenergie, 14: 319-22(Sept.-Oct, 1969). (In German).

In the frame of the linear and nonlinear stability theory it is shown that a nuclear power reactor is stable against bounded external reactivity perturbations if the power equilibrium point is asymptotically stable against $\delta(t)$- perturbations. 21 references. (auth)

45134 STUDY OF THE THERMAL AND DYNAMIC BEHAVIOR OF A GAS-COOLED NUCLEAR REACTOR UNDER VARIABLE RUNNING CONDITIONS. Rousseau, J. C.; Dobremelle, M. Bull. Inform. Sci. Tech. (Paris), No. 137, 45-52(May 1969). (In French).

In a system where a coolant gas exchanges heat with an energy generator and recuperator, thermal phenomena, under certain running conditions, can have an appreciable effect on the fluid flow characteristics and vice versa. To calculate transient phenomena under these conditions it is necessary to apply complete equations, particularly of momentum, mass and energy conservation. A computer code has been developed whereby all the dynamic characteristics of the fluid (flowrate, pressure and temperature), and also the temperature distributions inside the various media, can be known at each moment at each point of the circuit. The application of this code has been broached with the aim of determining the effect of an accidental shut-down of the blowers on the temperatures of the fuel and structures in a reactor of the Saint-Laurent I type cooled by pressurized CO_2. (auth)

45135 INPUT-NOISE SOURCE OF AT-POWER REACTORS WITH TEMPERATURE FEEDBACK EFFECT. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng., 37: 380-96(Sept. 1969).

Input-noise sources in at-power reactors are formulated under the basic assumption that a set of macrostochastic variables characterizing the state of the reactors has Markoffian properties. An input-noise source is defined as the ratio between the power-spectral density of fluctuations in the reactor-power level and the square modulus of the source-transfer function. Random birth and death processes of neutrons give rise to a "white" contribution to the input source. Additional contributions are found which have the break (roll-off) angular frequencies determined by the relaxation time constants of the feedback effects on reactivity. These "non-white" terms come from fluctuations in neutron-reaction cross sections caused by temperature variations. The ratio of the non-white to the white terms increases as the reactor power increases. It also depends on the magnitude of the reactivity coefficients of feedback. Before one evaluates the magnitude of the non-white noise term, however, there should be knowledge of some statistical parameters relating the noise to random emission of energy by nuclear fissions, random exchange between the fuel and the coolant in heat transfer reactions and random removal through the coolant flow. The formula for analyzing the power-spectral density of the temperature fluctuations is also derived where the same unknown statistical parameters appear. Measurements of both the power and the temperature fluctuations will serve to determine the parameters whereby one will be able to obtain better information on the time constant and the reactivity coefficient of each feedback effect. (auth)

45136 A SUFFICIENT CONDITION FOR THE FLATTENING OF THE THERMAL NEUTRON FLUX AND SOME RELATED PROBLEMS (IN ONE-DIMENSIONAL GEOMETRY). Zezula, Rostislav (Charles Univ., Prague). Apl. Mat., 14: 134-45(Apr. 1969). (In Czech.).

The problem of the distribution of fuel concentration inducing a given thermal neutron flux is discussed; the critical reactor core is homogenized with a given outer reflector boundary (in the two-

group diffusion approximation). Sufficient conditions for the existence of a one-parameter family of thermal neutron fluxes induced by a Goertzel type fuel concentration distribution are assumed. The flux of this one-parametrical family gives the maximum total output of the reactor. 6 references. (JPRS)

45137 HIGH-POWER KINETICS OF A TWO-DIMENSIONAL CIRCULATING FUEL NUCLEAR REACTOR. Kolar, Michael Joseph. Cleveland, Case Western Reserve Univ., 1968. 88p. Thesis.

A two-dimensional model of a single channel circulating fuel reactor is used to investigate the effect of a radial temperature distribution on the neutron kinetics. A slug flow model with no delayed neutrons is used. The effects of a nonuniform radial heat source distribution and thermal conductivity are taken into account. The effect of the reactor wall temperature distribution on the kinetics is discussed. (Diss. Abstr.)

Experimental Applications

45138 (BNWL-1099) MULTIDECADE NUCLEAR REACTOR SIMULATION USING HYBRID COMPUTER AUTOMATIC RESCALING TECHNIQUES. Patterson, J. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

A method of applying "floating point" techniques to an analog problem was used to simulate a nuclear reactor from startup level to full power. A hybrid computer was used to execute the problem, the digital computer being used to store and operate on the exponents of the variables, while the analog was used to operate on the mantissas. The method is an extension of the point storage (or analog memory) rescaling technique, and is applicable to a wide-range of multidecade problems. (auth)

45139 (RD/B/N-1188) SOURCE JERK EXPERIMENTS USING AN EXTERNAL SOURCE. Mountain, W.; Waterson, R. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). July 1969. 20p. Dep.

The extension of the source jerk technique to use on a reactor with an external neutron generator is described. The problems arising from the large spatial effects encountered are discussed, and the method of analysis employed is described. It is concluded that the technique as used gives an uncertainty of $<\pm 5\%$ on reactivity in the range from critical to $k_{eff} = 0.98$. (auth) (UK)

45140 (RD/B/N-1191) THEORY FOR SOURCE JERK EXPERIMENTS WITH AN EXTERNAL SOURCE. Bridge, M. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). July 1969. 30p. Dep.

The theory of the source jerk method was studied for some experiments in which the source was a neutron generating tube outside the reactor. The spatial dependence of the experiment was investigated using the CRAM program to predict initial and time-integrated fluxes in the reactor. A brief review of previous theoretical work on the source jerk experiment is given, and the development of the two-group theory as used in the present calculations is explained. The theoretical results, although not directly applicable to the particular experiments performed, are compared with some experimental results to confirm the general trend of the calculations. The calculations are used to indicate the measuring position for which zero spatial corrections apply. A calculation for a central source is compared with the cases for external source. (auth) (UK)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 43270, 43385, 43386, 43430, 43432, 43446, 43453, 43464, 43472, 43474, 43492–43502, 43938, 43942, 43943, 43955, 43962, 44006, 44009, 45029, 45046, and 45047.

45141 (ORNL-TM-2443(Add.)) PROFIL: A ONE-DIMENSIONAL FORTRAN IV PROGRAM FOR COMPUTING STEADY-STATE TEMPERATURE DISTRIBUTIONS IN CYLINDRICAL CERAMIC FUELS. Cox, C. M.; Homan, F. J. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 53p. Dep. CFSTI.

Four changes have been made in the PRØFIL code. A thermal conductivity function employing a polynomial curvefit of literature data has been added, primarily for carbide and nitride fuels. Alterations have been made in the flow diagram to simplify use of the code. A variable β factor has been added, which is porosity dependent; and the convergence criteria for calculating the temperature at the inside incremental boundary have been modified to increase flexibility. (auth)

45142 (UJV-2154) INFLUENCE OF SMALL CHANGES IN THE GEOMETRY IN A TUBULAR FUEL ELEMENT ON THE TEMPERATURE DISTRIBUTION. Pecha, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Apr. 1969. 18p. (In Czech). Dep.

The influence of small changes in the tubular fuel element geometry is investigated (supposing the axial symmetry of the fuel element is conserved). The effects of changes of individual dimensions (external and inner radius of the U tubes, external and inner thickness of the canning material, and inner radius of the Zr supporting tube) are estimated separately, and the total effect is considered. The extent of geometry changes in which assumption of cumulative effects can be used is discussed. The main purpose of the discussion is to give the basis of manufacturing tolerances of fuel elements composed of two U tubes. (auth)

45143 DETERMINATION OF THE IRRADIATION HISTORY OF SPENT FUEL ELEMENTS BY γ-SPECTROSCOPIC INTENSITY MEASUREMENTS OF FISSION PRODUCTS. Higatsberger, M. J.; Bruneder, H. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Acta Phys. Austr., 28: 94-108(1968). (In German).

A computer program for determination of the irradiation history for 2, 4, or any number of parameters is given. Isotope synthesis for ^{103}Ru, ^{106}Ru, ^{137}Cs, ^{95}Nb, and ^{134}Cs are represented in curve form as a function of the irradiation time in years in relation to the neutron dose with the isotope concentration/cm^3 as a parameter. (J.S.R.)

45144 HEAT ACTUATED CONTROL ROD UTILIZING A CADMIUM–POTASSIUM MIXTURE. Erickson, George F. (to United States Atomic Energy Commission). U. S. Patent 3,464,889. Sept. 2, 1969.

A control rod for a two-region nuclear reactor is described. The control rod utilizes the principle of a heat pipe with two different condensable vapors within an elongaged enclosure with a capillary lining, one having a high neutron absorption cross section at thermal energies. An increase in temperature of the reactor will send the high cross-section material into the thermal region, thereby slowing down the fission rate. (AEC)

45145 UO_2 NUCLEAR FUEL ELEMENTS (PELLETS). Nishijima, Toraji (Tokyo Shibaura Electric Co.). Powder Technol., 6: No. 2, 32-8(Mar. 1969). (In Japanese).

UO_2 pellets are used as the nuclear fuel for thermal reactors, power reactors in particular. Among the features of their production are the following: the relatively large amounts of their production, attended by the high yield; and the nuclear safety in their production. In the former, for a power reactor of electric output of 320,000 kW the UO_2 pellets for example may amount to about 60 tons, the number being 2,500,000. The accountability required by international agreements is very strict. In the latter, accidental criticality must be absolutely prevented. The UO_2 fuel elements and their industrial production are described. The historical background for uranium oxide fuels, the processes of production of the UO_2 pellets, in-pile behavior of the UO_2 pellets, and vibration-packed UO_2 fuels are discussed. (NSA of Japan)

45146 NUCLEAR REACTOR FUEL BUNDLE. Bigge, W. B.; Roupe, G. A. (to General Electric Co.). Canadian Patent 810,349. Apr. 8, 1969.

An improved method of reactivity control is proposed for a power reactor. Each fuel bundle consists of several fuel rods arranged in a predetermined geometric array having a square cross section. One or more bundles contain one or more rods which are individually removable and insertable without disturbing the other rods in the bundle. This may be done while the bundle is in the reactor. The removable rod is so constituted that the reactivity may be influenced in a desirable manner. There are also selectively removable control rods of cruciform cross section placed in the core between the fuel bundle channels. Several variations of the nature of the control methods are discussed and five operating examples are given. (F.S.A.)

45147 NUCLEAR REACTOR FREE-EXPANSION PRESSURE TUBE VESSEL. Hassig, J. M.; Peuchmaur, A.; Clamart, R. R.; Leval-lois-Perret, B. T. (to Commissariat a l'Energie Atomique) Canadian Patent 809,850. Priority date Aug. 14, 1964, France.

A nuclear reactor vessel contains a liquid moderator and is formed of two boundary heads. Each head is made of one plate, an outer cover and several fuel pressure tubes extending between

the boundary heads. The vessel comprises a tight and flexible connecting element fixed to the outer cover and to one of the boundary heads by thin welds. There is also another tight and flexible connecting element fixed to the outer cover and to the other boundary head by thin welds with a sleeve mounted around each of the fuel pressure tubes across each of the boundary heads. Each of these sleeves is fixed to the boundary head by thin welds. Such an arrangement allows the outer cover to expand freely in response to gas coolant temperature variations independently of the fuel pressure tubes. The tight and flexible elements are made of stainless steel. (F.S.A.)

45148 LARGE NUCLEAR REACTOR PARTIAL SHUTDOWN SYSTEM AND METHOD THEREFOR. MacKay, I. N. (to Canadian General Electric Co., Ltd.). Canadian Patent 813,547. May 20, 1969.

For large power reactors of about 750 MW it is proposed to divide the reactors into zones which may be selectively shut down while power is still available from other active operating zones. The plan includes a reactor containment vessel, several groups of nuclear fuel within the vessel, separate heat transport circuits within each zone, and reactivity control means to selectively control the level of activity of the fuel groups whereby partial shutdown can be effected. The boundaries of a zone are defined by the presence of insertable booster material in the form of enriched fuel rods so that in the event that one portion of the reactor is shut down, the neutron activity of the adjacent portions can be maintained at a power level close to normal. Vertical pressure tubes with heavy water as the moderator and heat transfer agent are contemplated. Operation at 50 to 80% of full power is suggested during these partial shutdowns. (F.S.A.)

45149 METHOD AND APPARATUS FOR CONTROLLING THE OUTPUT OF A NUCLEAR REACTOR. Gilbert, J. (to Sulzer Brothers Ltd.). Canadian Patent 813,546. May 20, 1969. Priority date Nov. 16, 1964, Switzerland.

Control is achieved in response to a signal produced by the difference dependent on the neutron flux and the heat output of the reactor. The system depends on devices for sensing the neutron flux at various locations and measurements of the coolant flow and temperature. Rapid shutdown, when required, is brought about by insertion of conventional control rods. (F.S.A.)

45150 COMPUTER REPRESENTATION OF A NUCLEAR POWER PLANT IN A TRAINING SIMULATOR. Bennett, C. Michael (General Electric Co., Daytona Beach, Fla.); Ahner, D. J.; Ferguson, J. H.; Battuello, F. L. ISA (Instrum. Soc. Amer.), Proc., Int. Power Instrum. Symp., 11: 15-27(1968).

From 11th International Power Instrumentation Symposium, Chicago, Ill. See CONF-680551.

A General Electric process computer (GE/PAC 4020) is used in conjunction with a high speed, solid state input-output system to implement a real-time software simulation of the boiling-water nuclear reactor, plant power generating equipment, and auxiliary systems dynamic response to operator actions. Simulator control panels duplicate the configuration of an actual nuclear power plant control room. Real plant panel instrumentation, through appropriate signal conditioning, provides the operator the same feel and sense of a maneuverable plant. A special-design console allows instructors to rapidly initialize the "plant" to various operational modes and to inject system malfunctions to develop operator proficiency in responding to abnormal and emergency situations. 2 references. (auth)

45151 SAFETY RODS FOR NUCLEAR REACTORS. de Paratesi, Sergio Galli; Genet, Francois; Ghiurghi, Luciano; Agazzi, Alberto; Broggi, Armando; Morbello, Mario (to EURATOM). British Patent 1,161,454. Aug. 13, 1969. Priority date Mar. 22, 1966, Belgium.

REACTOR CONTROL ELEMENTS—liquid in tube type, description of gas pressure actuated (D.C.C.)

45152 NUCLEAR FUEL SORTING MACHINE. MacKay, I. N. (to Canadian General Electric Co., Ltd.). Canadian Patent 815,749. June 17, 1969.

To keep the neutron flux reasonably uniform in all parts of a power reactor, it is necessary to shuffle the fuel bundles so that all will be subject to about the same burnup. To accomplish this purpose a machine to change the position of given bundle and to replace depleted ones is proposed. It is intended to operate in conjunction with a reactor fuelling machine and requires suitable shielding and remote handling means because the fuel bundles are highly radioactive. The basis of the device is a rotary magazine which permits the rearrangement of fuel bundles as taken from the reactor, the addition of new ones as required and the conveyance of depleted bundles to a spent fuel bay. A system of rams and other associated equipment for rearranging the bundles is described. (F.S.A.)

45153 NUCLEAR REACTOR VERTICAL REFUELLING MACHINE. MacKay, I. N. (to Canadian General Electric Co., Ltd.). Canadian Patent 815,750. June 17, 1969.

A simply operated, mechanically interlocked machine is described for changing fuel in a vertical reactor from below. The essential parts are an elongated vertically extending flask, tracked transport means for moving the flask horizontally into coincidence with the lower end of a selected fuel tube, lifting means to move the flask vertically into and out of engagement with a selected fuel tube end, and flask suspension means permitting tilting of the flask from a vertical position to a position angularly inclined whereby upon engagement with a selected tube end, slight vertical misalignment between the tube and the flask is permitted by tilting the flask about the suspension means. Suitable locking-on attachments and valves are provided so that pressurized coolant may continue to flow in the fuel channel and in the flask during the fuel changing operation. A rotary magazine arrangement is included having an axis of rotation parallel with the main axis of the flask and a ram movable from a first position beneath the fuel magazine, permitting indexing into axial alignment with the pressurized fuel channel. The ram then moves vertically through the magazine to a second position for penetration into the fuel channel. (F.S.A.)

45154 DEVICE FOR OPERATING NEUTRON-ABSORBING RODS IN NUCLEAR REACTORS. Olsson, C. S. (to Aktiebolaget Atomenergi). Canadian Patent 812,999. May 13, 1969. Priority date Oct. 15, 1964, Sweden.

The device consists of vertical cylinder above the reactor core, a slide which is axially movable in the cylinder which supports a vertical absorbing rod and which has a plunger at its upper end. There is a means for supplying a pressurized fluid to the space defined by the cylinder. A slide and plunger for holding the slide in its upper position retains the absorbing rod normally above the reactor core. The cylinder and slide has recessed portions along its operative length. These recessed channels form channels through which the pressurized fluid can leave the space when the slide leaves its upper position after the supply of pressurized fluid has been cut off. The result is that the absorbing rod can fall freely into the reactor core by its own weight. (F.S.A.)

45155 FUEL FOR NUCLEAR REACTORS. Higatsberger, M. J. (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). Canadian Patent 815,982. June 24, 1969. Priority date Apr. 26, 1963, Austria.

Nuclear fuel elements of various shapes embedded in a moderator matrix are described. By incorporating at least two of Ag, Be, Ta, Mo, Si, Se, Zr or their compounds into the matrix, non-volatile fission products will be bound in the fuel particle and thus prevented from becoming a contamination problem. Operating temperatures up to 1000°C are mentioned. About equal quantities of nuclear fuel and the substances for binding the fission products are encapsulated into particles. (F.S.A.)

GENERAL

45156 (AEC-tr-6872/1) COMPUTER ELEMENTS AND SYSTEMS. Collection of Papers Issues Nos. 15–19, 1965. Translation of Comput. Elem. Syst. (USSR) (Engl. Transl.), Nos. 15, 16, 17, 18, 19(1965). 557p. (TT-69-55012/1; IPST-Cat-5075-5079). Dep. CFSTI.

45157 (CEA-Bib-1004(1968)) RECAPITULATION OF CEA REPORTS. 12 Series: Original Reports, 1968. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1969. 204p. (In French). Dep. CFSTI (U. S. Sales Only).

45158 (COO-1018-1187) TECHNICAL PROGRESS REPORT. PART I. Report No. 342. (Illinois Univ., Urbana. Dept. of Computer Science). July 23, 1969. Contract AT(11-1)-1018. 59p. Dep. CFSTI.

Development of the Illiac III computer system is described in terms of 14 constituent subsystems of processors, units, and peripheral device groups. Software developments including the operating system and translators are discussed. Also, accomplishments in pattern recognition theory are presented; and publications, papers, talks, and reports are listed. (W.H.K.)

45159 (EUR-4256) 1968 MEETING OF EUROPEAN LIBRARIANS WORKING IN THE NUCLEAR FIELD. A Selection of Papers Read at the 5th Annual Meeting of Scientific Librarians Organized by the Centre for Information and Documentation (CID) and the Scientific Information Processing Center (CETIS) at Stresa (Italy), April 24–25, 1968. (European Atomic Energy Community, Luxembourg. Center for Information and Documentation). June 1969. 116p. (CONF-680462). Dep. CFSTI (U. S. Sales Only). EUR FF 16.50.

Topics include introduction of mechanization in scientific libraries, automatic indexing as a complement to the semi-automatic documentation system, the use of machine translation in scientific documentation, and the experience acquired by CID in operating the European Nuclear Documentation System. (W.H.K.)

45160 (LA-4200) LIST OF JOURNALS WITH HOLDINGS, 1969. (Los Alamos Scientific Lab., N. Mex.). June 1969. Contract W-7405-eng-36. 372p. Dep. CFSTI.

45161 (NP-17988) ANNUAL REPORT, 1968–69. (Department of Atomic Energy, Bombay (India)). 83p. Dep. CFSTI (U. S. Sales Only).

The annual report includes brief discussions on the Bhabha Atomic Research Center, Tata Institute of Fundamental Research, Physical Research Laboratory, Saha Institute of Nuclear Physics, Tata Memorial Center, space research, Atomic Minerals Division, industrial operations, atomic power, and international relations. (B.G.D.)

45162 (NYO-2651-21) LOCALIZATION OF ANTIBODIES IN SPONTANEOUS AND INDUCED TUMORS. Comprehensive Report of Overall Activities, November 1, 1960–July 1, 1969. (New York State Dept. of Health, Albany). Contract AT(30-1)-2651. 26p. Dep. CFSTI.

Research activities during the course of this reporting period included: production and localization of antibodies to acetaminofluorine-induced hepatomas in rats; cross reactions in hepatomas with antisera prepared against individual hepatoma nodules and normal liver; identification of proteins of immunoglobin (IgG) associated with the microsomal membrane of autochthonous hepatomas and normal liver of rats; localization of binding sites of acetaminofluorine to tissues of liver or kidneys of rats; in vivo localization of antibodies to the lymphocytic leukemia of mice using antibodies produced by cultured leukemia cells; specific in vivo binding and localization properties of normal globulin components; distribution of histocompatibility isoantigens in tissues of mice; determination of antibodies formed in rabbits against antigens of cultured human leukemia cells for radioimmunoassay of specific antigens; localization properties of anti-Molony lymphoma antibodies in isogeneic mice; in vivo immunosuppressive activity of rabbit antisera, directed against cultured cells of mouse lymphocytic leukemia; and localization of mouse alloantibodies of known specificities. Statements concerning the pertinence of these findings to the original objectives and plans for continuation of the project are also included. (E.R.B.)

45163 (ORNL-4416(Vol.1)) KWIC INDEX FOR MATRICES IN NUMERICAL ANALYSIS. VOLUME I. PRIMARY AUTHORS A–J. Householder, A. S. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 129p. Dep. CFSTI.

This index contains about 1200 items considered relevant to the numerical treatment of matrices, determinants, and linear systems of equations. It includes books, reports, and periodical articles whose primary authors occur alphabetically between A and J. Subsequent volumes will extend and update the listing. (auth)

45164 (ORNL-TM-2690) A NOTE ON THE APPLICATION OF LIE GROUPS TO THE INTEGRATION OF FIRST-ORDER PARTIAL DIFFERENTIAL EQUATIONS. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Sept. 4, 1969. 19p. Dep. CFSTI.

The solution of first-order partial differential equations in two independent variables that are invariant under the transformations of a two-parameter group is studied. The equations need not be linear. (auth)

45165 (SC-M-69-465) GERBER FORTRAN PLOTTING PACKAGE. Plomp, P. W. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 68p. Dep. CFSTI.

A users manual for individuals wishing to use the Gerber Series-1000 Automatic Drafting Machine via Fortran computer programs is presented. The subroutines are described which generate the required control media for the Gerber. (auth)

45166 (SC-M-69-466) GERBER FORTRAN PLOTTING PACKAGE SYSTEM DESCRIPTION MANUAL. Plomp, P. W. (Sandia Labs., Albuquerque, N. Mex.). Aug. 1969. 167p. Dep. CFSTI.

The Fortran subroutines of the Gerber Fortran Plotting Package are described. The routines are available for usage on the IBM-7090, CDC 3600, CDC 6600 and the UNIVAC 1108. The routines are described as a general computer package, but peculiarities are recorded by computer name. The manual contains a summary of all subroutine calls in the package, a brief description of each subroutine and its purpose, and definition of all variables. (auth)

45167 (STI/DOC-11(Vol.7)(No.2)) LIST OF BIBLIOGRAPHIES ON NUCLEAR ENERGY. VOL. VII, NO. 2. (International Atomic Energy Agency, Vienna (Austria)). 1969. 28p. Dep. CFSTI (U. S. Sales Only).

A list of 120 bibliographies, either published or in preparation, on various aspects of nuclear science is presented. Personal author and corporate author indexes are included. (W.H.K.)

45168 (TID-3753) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period May–June 1969. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 10p. Dep. CFSTI.

45169 (UCLA-34-P-91-25) HEAVY ATOM, VIBRONIC, AND HOST CRYSTAL PERTURBATIONS ON THE PHOSPHORESCENCE OF MOLECULAR CRYSTALS. Annual Report, September 15, 1968–September 14, 1969. Ziegler, Stanley Martin (California Univ., Los Angeles. Dept. of Chemistry). Contract AT(11-1)-34. 325p. Dep. CFSTI.

The effects of some weak perturbations on the phosphorescence mechanism were studied by investigating the polarized phosphorescence spectrum of mixed single crystals of quinoline, isoquinoline, and their halogenated derivatives in biphenyl and durene host crystals at 4.2°K and 77°K. The spectrum of the parent compound, Subspectrum I, was found to persist in the halogenated derivatives. In addition, there appear new bands characteristic of the halogenated molecule, Subspectrum II. Subspectrum I was found to be out-of-plane polarized for most guest molecules in biphenyl. The origin of Subspectrum I is a first-order spin-orbit perturbation which mixes the out-of-plane singlet states with the in-plane emitting triplet state. There appear bands at $0,0,0^{+}792$ cm^{-1} for quinoline, and $0,0,0^{+}777$ and $0,0,0^{+}939$ cm^{-1} for isoquinoline in biphenyl, which are in-plane polarized in contrast to the rest of the spectrum. The role of the singlet (n,π^{*}) state present in the heterocyclics with respect to the out-of-plane emission was investigated and it appears that it does not play an important role in the phosphorescence mechanism in biphenyl host crystal. The large amount of out-of-plane emission for the halogenated molecules in durene, in contrast to quinoline and isoquinoline which are almost totally in-plane polarized, indicates that the singlet (n,π^{*}) state may be playing an important role in the guest emission in durene host crystal. The guest emission in biphenyl host crystal appears somewhat broad and shows a high degree of coupling with the lattice. The similar

polarization of the phonon and phononless bands indicates that there is no perturbational effect of the lattice modes on the guest emission in biphenyl. It was found that considerations of relieving the strong host hydrogen-guest halogen repulsive interactions for the α and β substituted heterocyclics could accurately predict which lattice modes would appear coupled with the guest emission in biphenyl. In contrast, the guest emission in durene is very sharp and shows little or no coupling with the lattice. (auth)

45170 (UCRL-50584) DYNAMIC MECHANICAL PROPERTIES OF THE BLU-31/B MINE STRUCTURE. Hoge, K. G.; Morris, R. V. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 3, 1969. 14p. Dep. CFSTI.

The mission of the BLU-31/B mine was modified to include penetration of about 6 ft of concrete. Sled tests which were made to evaluate the performance of the mine at high speed impacts showed that the steel case failed. In order to analyze the cause of case failure, the dynamic mechanical properties of both the case and explosive materials were obtained. An Instron universal test machine was used to obtain data at strain rates below 1 sec^{-1}. Data at rates of 10 to 200 per sec were obtained on a modified Dynapak machine. The Hopkinson split-bar technique was used to obtain dynamic data at strain rates approaching 10^4 sec^{-1}. The steel case material was tested in both compression and tension. The mock explosive material, consisting of a concrete and cork mixture, was tested in compression only. The explosive material, Tritonal, was not tested because the material which was supplied was too porous and brittle to fabricate specimens. Data indicate that the steel case material increased its strength moderately as the strain rate was increased. More importantly, however, the case material retained its ductility with increasing strain rates. The mock explosive material was fairly sensitive to strain rate effects. Because this material was quite brittle, considerable scatter was noted in the data. (auth)

45171 (UCRL-50679) METHOD FOR EVALUATION AND CERTIFICATION OF THE MOORE MODEL NO. 3 UNIVERSAL MEASURING MACHINE. Lane, Donald L. (California Univ., Livermore. Lawrence Radiation Lab.). June 1969. 55p. Dep. CFSTI.

Thirty-seven evaluation and certification tests developed at Lawrence Radiation Laboratory for the Moore Model No. 3 Universal Measuring Machine are described. Photographs of each test setup are included. Also given are strip chart recordings demonstrating the unique capabilities of an extremely sensitive instrument that detected an error caused by brinelled thrust surfaces of the lead screw. (auth)

45172 (UCRL-50701) PRIORITY STRUCTURE FOR MULTI-ACCESS MEMORY SYSTEMS. Hill, James Carver (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1969. 90p. Dep. CFSTI.

Thesis.

The quest for greater computer-system speed has brought about a continuing increase in the parallelism of these systems. In particular, the number of processors and other devices which are required to access the same core-memory — not for economy, but for the advantages to be derived from using the memory as an exchange for data and control information — has increased markedly. That portion of such multiaccess systems which allocates the memory accesses available at a given instant of time among the devices then requesting access to memory is denominated the priority structure. Three attributes are desirable in a priority structure: 1. It should service all requesting devices within the limits of their patience; i.e., the latency of each memory-accessing channel should be less than the patience of the corresponding device. 2. It should be efficient in that all accesses available from the core-memory are made available to devices. 3. It should be modularly constructed and reconfigurable so that no single component is absolutely necessary for system operation; i.e., it should introduce no intrinsic point of permanent articulation. Priority structures used heretofore, principally strict-priority and first come-first serve, do not exhibit all of these characteristics: First come-first serve systems, although efficient, are incompatible with devices of small patience unless intrinsic points of permanent articulation are allowed. Strict-priority systems, are generally not 100% efficient, have variable channel latencies, but are favorable to the elimination of articulation points. Their inadequacies are not a result of the idiosyncrasis of a particular hardware implementation but are shown to be, in each case, a fundamental shortcoming of the service discipline itself, when applied to multi-access memory systems. An alternate discipline, limited-latency, is developed which does exhibit all of the desired characteristics. In an example of this discipline, each multiplexor, at each level, in the memory-access structure is required to contain a cycle-counter, the states of which are decoded so as to guarantee each input channel some fraction of the total number of cycles available to that multiplexor. Necessary, or desirable, restrictions on the sequence of guaranteed-fractions to be so obtained are derived and their consequences are discussed. Finally, it is shown that the limited-latency structure is a general scheme, independent of ad hoc hardware considerations, which can serve as the basis for particular designs. (It does, in fact, include first come-first serve and strict-priority as special cases.) (auth)

45173 (WAPD-TM-791) GAPL-3: COMPUTER PROGRAM FOR THE INELASTIC LARGE-DEFLECTION STRESS ANALYSIS OF A THIN PLATE OR AXIALLY SYMMETRIC SHELL WITH PRESSURE LOADING AND DEFLECTION RESTRAINTS. Thurman, A. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1969. Contract AT-11-1-GEN-14. 83p. Dep. CFSTI.

GAPL-3 is a computer program which performs an elastic-plastic, large-deflection analysis of thin plates and axisymmetric shells with pressure loading and deflection restraints. The solution is obtained by a discrete element method employing a double layer of elements to facilitate approximation of the inelastic stress state. The program is written in FORTRAN IV for the CDC-6600 computer. (auth)